" L.B.S.C."

" JULIET "— THE SIMPLEST YET

HERE is a general arrangement drawing, and the first details, of the simple locomotive promised for beginners and others who have neither the skill nor equipment necessary to build the " Lassie." As long as our friend of the blue pencil doesn't mind, the few special instructions needed for doing the job, can easily be squeezed in between the " Lassie " notes. This should satisfy the good folk who are anxious to get started right away, instead of having to wait until their more experienced confreres have finished their little bit of perambulating mechanism. Builders of the simple engine should, however, read and very carefully digest all I have to say about the " Lassie," because much of the detailed instructions given for any one particular engine, is applicable to all. Useless repetition is both a waste of space, and is unfair to other readers ; so let's to business.

The engine is an adaptation of the small four-wheeled shunting tanks used by the main-line railways, and by various industrial concerns. Most engines of this type are saddle-tanks, but I am specifying side-tanks, first because they are easier to make and erect, and secondly because the water in saddle tanks usually becomes hot, taking heat from the boiler, and cooling it when refilled with cold water. Eh ! what's that? Why, to be sure I know there is such a thing as lagging, which can be placed between boiler and tank; but do you realise that the small boiler reaches exactly the same temperature as a big one carrying steam at the same pressure ? Also that the water used to fill the tank is at the same temperature, whatever the size of the engine? Consequently, to insulate the boiler from the tank effectually, you would need a thickness of lagging approximating to that of the full-sized engine, making her look a bit comical, to say the least !

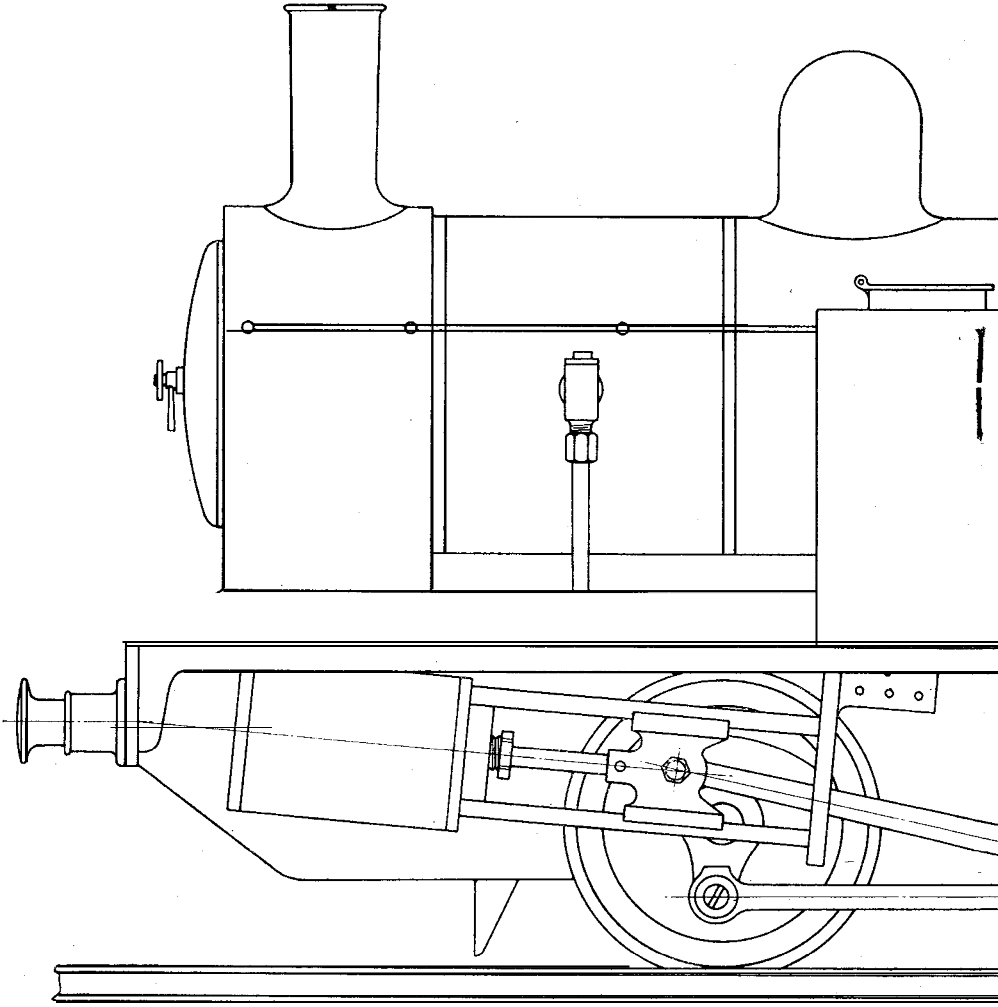
She Will Take Sharp Curves

To satisfy the good folk who are continually asking what is the minimum radius a small passenger-hauling locomotive can be made to negotiate, this one has been especially schemed out to run around the "Johnny Horners." I mentioned in the brief "foreword" that she would take a circle 15 ft. in diameter easily, but this isn't the minimum, by long chalks, as she will actually go around a circle half that diameter, provided that the driver doesn't exceed the speed limit and have her off the road. However, she would be driving on one side of wheels all the time, as the other side would be continually slipping, owing to the difference in length of the inner and outer rails of the circle. Also, there would be a terrible bit of flange friction; and on a passenger car running on such small radius curves, the flange friction would be equivalent to having the brake partly on, the whole of the time. In addition, the weight of the rider on the car would make it very difficult for the outer wheels to slip the required amount to negotiate the curve, so that independent wheels would be needed, running loose on the axles, with the ball bearings in the wheels themselves. All these troubles would not be so much in evidence on a circle of 15 ft. diameter or over ; so builders of the engine shouldn't worry their noddles about the ***minimum*** radius she will negotiate, but concentrate on laying out the ***maximum*** radius in the available space. If you can squeeze in a few feet of straight line, do so by all means, as it gives the engine a slight let-up on the everlasting flange-grinding.

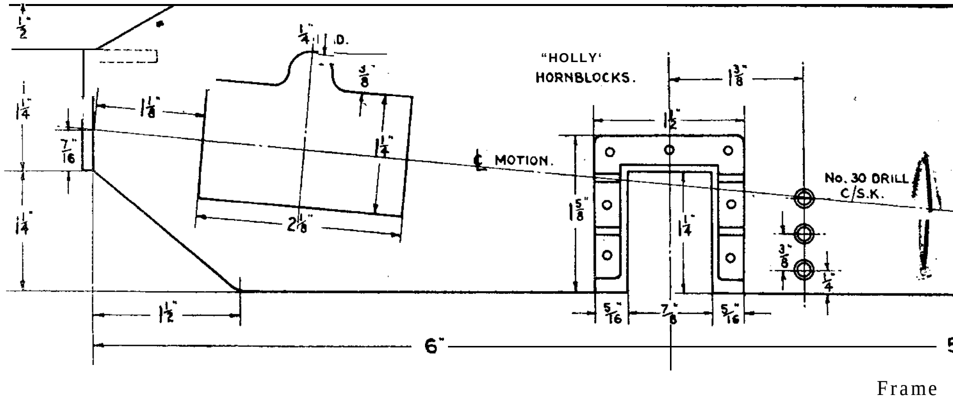
Simple Specification

The main frames are "straight line " pattern, with buffer-beams of steel angle, and one evening's work should see the whole doings cut out and erected. The horn-blocks and axle-boxes are same as " Molly " and " Iris," but no spring pins are needed, the springs being on top of the axleboxes, in plain drilled pockets, The four-coupled wheels are 3 in. diameter, which brings them below the running board and dispenses with splashers ; they are a stock size. Coupling- and connecting-rods need not be fluted ; the connecting-rod has a plain bushed big-end. Cylinders are same pattern as " Iris," but slightly smaller, being 1-in. bore and 1-1/2in. stroke, equivalent to 16 in. by 24 in. in full-size, about the average for driving four-foot wheels. They are exceptionally easy to machine and erect, being located automatically by the openings in the frame, and the steam and exhaust connections are simple. Lubrication may be by a displacement oiler, or a mechanical lubricator according to builders' skill or desire. The valves are operated by simple loose eccentrics. Nothing more is needed on a small continuous road with sharp-radius curves, as the engine does not have to be continually reversed, as on an up-and-down road ; and a fairly late running cut-off is needed, on account of the tractive effort required to overcome flange-friction and one-side-wheel slip on the car carrying passengers, especially if they are heavy adults. There is also the advantage of one solitary pm-joint only, between eccentric and valve, retaining accurate valve-setting indefinitely ; and the port openings can be made absolutely equal at both ends of the valve movement The rawest tyro can make and erect the gear, and set the valves, as well as any " expert."

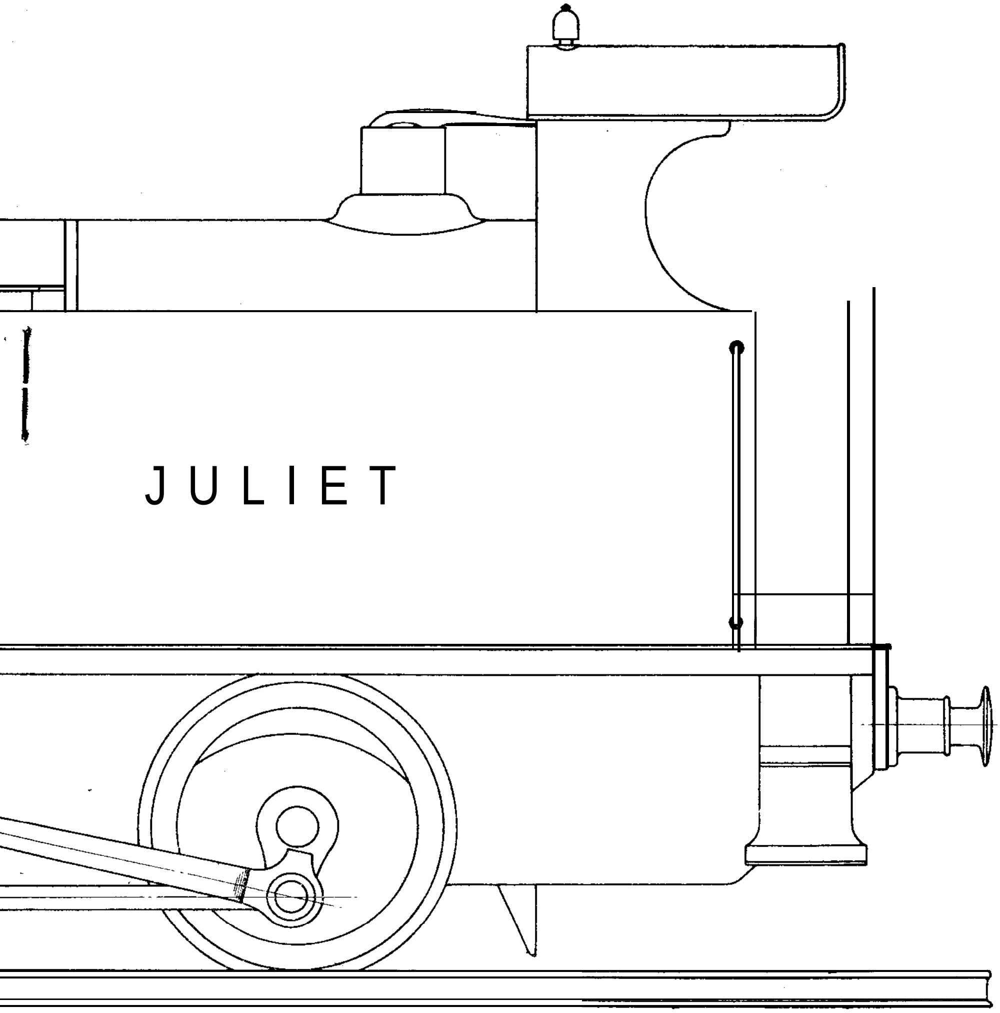
The boiler is small, being no larger in diameter than the average 2-1/2in. gauge Pacific, and has a fairly deep firebox, which doesn't mean that same has to be filled up to the crown sheet-another exploded "law of the Medes and Persians ! "About an inch or so of fire on the bars, should be ample, as the upper part of the firebox acts as a combustion chamber ; and this



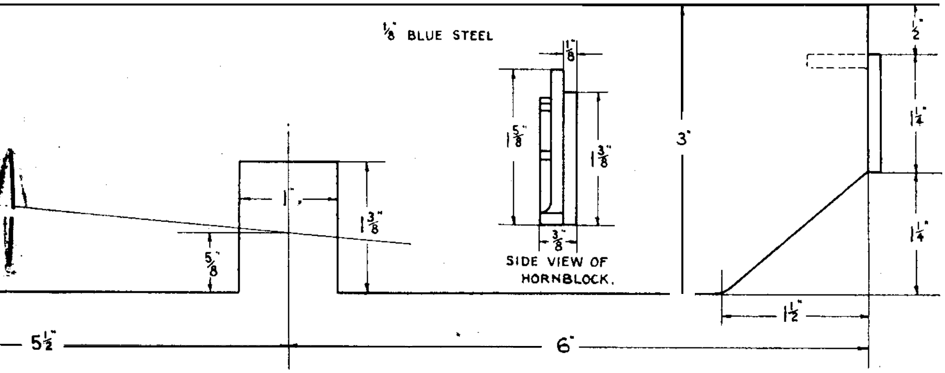
A simple 3½-*in.* **gauge** *locon*



Frame

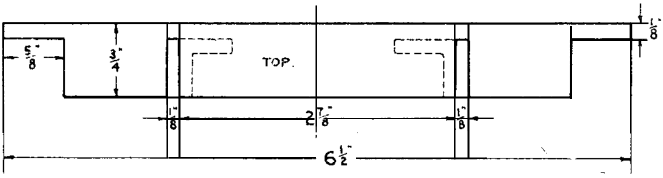


locomotive to fill many needs



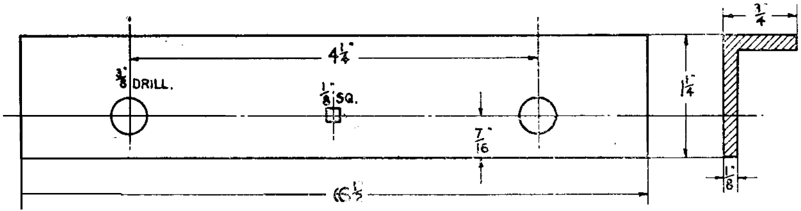
me

will provide all the steam required for non-stop running with a normal load of about three adults, or two adults and two children. The engine will, however, pull much more than that, only you would need to fire her more frequently, and look after the feed-water, which is supplied by a pump driven by an eccentric on the driving axle. It by-passes direct into one of the side tanks. An emergency hand pump is also located in one of the tanks, and operated by an extension handle through the filler hole, as on my tender engines. An injector can be fitted if desired. The smokebox can be a one-piece casting, as sold for " Petrolea " which incorporates a saddle and saves a vast amount of work, or it may be built up from a piece of tube, with ring and door made from brass blanks, the whole mounted on a saddle bent up from 16-gauge sheet metal. I have shown a plain stovepipe chimney, as on " Petrolea " ; but builders can, of course, turn the outside to their own pet fancy, and have a bell-top, black or polished. Either " Petrolea " or " Molly " dome casing can be used. The safety valve is a single column ball pattern (non-pop) with a Ramsbottom casing over it.



Top of both beam

The side tanks are made from brass sheet, and each has a short piece of tube soldered to it, so that same may be connected by a slip-on rubber hose under the boiler barrel. This is quite satisfactory, as there is neither heat nor pressure to withstand. The cab has an open back, and the boiler extends into it, level with the end of the side sheets, or " weather-pieces " as enginemen sometimes call them ; this makes the handles accessible. No coal is carried on the engine, the bunker sheet being cut away in the middle, to give easy access to the firehole. For firing on the run, it is easy enough to carry some coal in a small box on the leading end of the passenger car.



Buffer-beams

Apart from its ability to run on any road, and around any radius curve within reason, the engine, though powerful, is small and portable, just the ticket for taking along for a run over a friend's line ; and apart from the ease of construction, the cost of the castings and material would come out less than a full set for a 2-1/2in. gauge engine of express or heavy goods pattern, which wouldn't even look at the curves which this small 3-1/2in. gauger would negotiate with ease.

Frame Details

Two pieces of 1/8in. soft blue steel, each 17-1/2in. long and 3 in. wide, will be required for the frames, which are marked out as shown, temporarily riveted together, and sawn and filed to outline. When marking-out, the only point needing particular attention, is the location of the rectangular hole for the steam chest. This is set out on the centre-line of motion; to get which, from a point 7/16 in. above the bottom of the front vertical line of frame, strike a line through the centre of the driving axle, which will be 5/8 in. above the bottom of frame, in the middle of the driving horn-slot. On this line starting at 1-1/8in. from the front end of the frame, set out the opening 1-1/4in. wide and 2-1/8 in. long, as shown. The little archway on the top centre is for the exhaust pipe. The screwholes behind the leading horn-slot, are for the screws holding the pump stay.

Get four "Molly " hornblock castings, and machine or file them up as described for the "Lassie." Rivet them into the slots in the frame with seven 3/32in. rivets in each ; then smooth off the lugs, and the inner' faces of the jaws, with the frames temporarily screwed together " inside out " as the kiddies would say.

The buffer beams are two 6-1/2in. lengths of 1-1/4in. by 3/4in. by 1/8in. angle, steel for preference, though brass would do at a pinch. If you can't easily get the unequal angle, use 1-1/4in., and saw off the unwanted part from one of the angles. The illustrations show the slotting and drilling required on each ; unlike a tender engine, both are alike. If steel angle is used, there is no need to bother about fitting small pieces of angle for attaching side frames ; but if brass, put two short pieces of angle on the inner side of each slot, as shown by dotted lines. When assembling, the main frames are attached to these by four $-in. screws in each angle.

If steel angles have been used, jam the ends of the frames into the slots in the angle ; stand the lot on your lathe bed, and line up frames and beams as described for the " Lassie." Put a block of hard wood 2-7/8 in. wide, between the frames, in the centre between the hornblocks, and put a big toolmaker's cramp over the lot, to prevent the frames from slipping out of alignment whilst being brazed. A small carpenter's cramp will serve the same purpose. Then upend the frame assembly in your brazing pan-see " Lassie " boiler-brazing instructions last week, for requirements in the brazing line-and braze the frames to the beams, using Boron compo as flux, and ordinary soft brass wire as " spelter." This melts at bright red. runs well into the joint, and makes a sound job. Beginners remember, iron and steel is never acid-pickled after brazing; quench out in water only. The heat of the brazing operation, which can be done with a one-pint lamp or small air-gas blowpipe, won't travel far enough up the frames to burn the wood spacer. After brazing all four corners, scrape off any traces of the flux which may be sticking to frames and beams, and test again for alignment, in case anything has shifted. Next job, axleboxes and wheels-

Daylight at Night in the Workshop

It is a pretty safe bet that the great majority of the followers of these notes spend their days earning a living, and only pursue their hobby in the evenings ; which means that during the next few months it will have to be done by artificial light. Now a good light is essential for accurate work, but like many other good things, it is possible to have too much of it : and a powerful electric bulb close to one's eyes is positively harmful. The late Mr. Cecil 0. Purdey, who was a wonderful craftsman, told me he ruined his normal eyesight and had to use powerful glasses at quite an early age, through setting gun-sights by aid of an arc-lamp. He was the proprietor of the well-known sporting-gun firm of that name. My own eyesight is still wonderfully good, and it is hardly necessary to add that I am still doing my best to take care of it, as I have done all through life ; yet friends 15 to 20 years younger, are complaining of faulty sight. One mentioned in a recent letter. that he couldn't even see to repair his lighter without glasses ; I could have replied that the lighter itself was a contributory cause, as he is a heavy smoker, and tobacco smoke in one's eyes all day long, doesn't do them any good, as I learned from the books on human physiology which I studied in my young days.

As mentioned some time back in a lobby chat, I always use an eye-shade with a couple of intensifying lenses in it, when working, and thus can avoid any eye-strain ; but I have often noticed that daylight is better than artificial light for working. and wished that I could introduce a spot of daylight into my workshop " after set of sun," as the poet says. A few days ago, time of writing, that wish actually became a reality, and this is how it came about.

Lighting by neon tubes, or fluorescent tubes is now fairly common in large factories, and small single units are also being produced for use in shops. Often, of an evening, I take a stroll over to the local sorting office, to get a breath of fresh air and deposit the answers to the day's correspondence in the letter box ; and not so long ago I noticed that two or three of the local shops had installed fluorescent lighting units close to the ceilings, which gave a daylight effect to the whole of the floor space, a quite brilliant illumination sans glare and shadows. That started an idea ; why not put one up in my workshop ? Having a valued friend in one of the big electrical firms, I got in touch with him, with-a view to obtaining one of the units to try out. He came up to scratch quite nobly, and in due course delivered a unit six feet long, consisting of a trough reflector with an oblong box on it containing all the blobs and gadgets, and underneath, in the trough, a 5 ft. fluorescent tube. Gee-whiz, thought I, now we'll be able to see where the 10-B.A. screws go when they fall off the bench ; and so it proved.

I made up a couple of screwed-shank rings, screwed them into the ceiling joists, and hung up the unit as close to the ceiling as possible, connecting the two leads to the ceiling rose which had carried my central pendant fitting.

When I switched on for the first time, there were a few flashes of summer lightning as the fluorescent tube started business, and then-oh, boy! Daylight after sunset had, in actual reality, come into my workshop. At time of writing, I have only had the unit installed for a few days, but am already feeling the benefit of it, as there is absolutely no eyestrain, the light is glareless and shadowless, and the yellow tinge of the electric bulbs is entirely absent. I heard that there would possibly be strange effects, such as the lathe chucks apparently-going the wrong way, but have not found anything different. Anyway, I am highly delighted with the improvement ; and-tell it not in Gath !-the Scottish part of my make-up rejoices in the reduced current consumption, the tube using less than an ordinary 100-watt bulb ; loud cheers from Mr. Shinwell !

THE STEPHENSON LOCOMOTIVE SOCIETY

A red-letter day in the Society's programme of outdoor visits during the past summer was the tour of the Longmoor Military Railway and Training Establishment in Hampshire, by courtesy of the Commandant and Officers, who provided every facility for the party. Travelling by special train hauled by a W.D. 0-6-0 saddle tank, which included in its formation an F. W. Webb ex-L. & N.W. 6-wheeled saloon, a tour was made of this remarkable line and its more recent extension, calls being made at the well equipped signalling school as well as at the prefabricated-bridge depot. Among the locomotives were seen ex-M. & G.N. Joint, L.B. & S.C., Taff Vale, North Stafford, and G.W. representatives as well as diesels, Ministry of Supply 2-8-0s and 2-10-0s some being painted blue and named.

By kindness of the L.N.E.R. a largely attended visit to the works and Running Sheds at Doncaster provided much of interest to general observers also to those members specialising in photography.

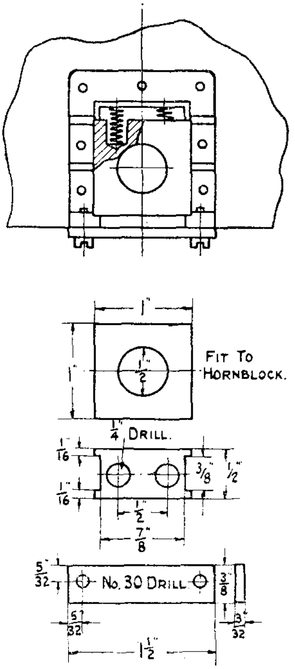
The Society's permanent headquarters opposite Addison Road Station, Kensington, London, W.14, was opened in October.

General Secretary : H. C. CASSERLEY, Ravensbourne, Berkhamsted, Herts.

“L.B.S.C.” expounds the 0-4-0 side tank

“JULIET”

BEFORE proceeding with more details of the little passenger-hauling engine that will run around the edge of. a dinner-plate, here is an item of news. Some of our readers have a hankering after a simple locomotive on 7-1/4in. gauge, and are not satisfied with any existing design because it doesn’t conform to “ Live Steam” specification and is not “ genuine Curly,” so they want to know “what I’m going to do about it.” Well, let these good folk get ***some*** 3/16in. steel plate and angle, and exercise their muscles, hacksaws, and files in carving out a pair of frames and a couple of buffer-beams to double the dimensions given for “ Juliet.” Don’t cut any slots in the beams for fitting frames, as I haven’t yet settled what will be a suitable width for this size, at time of writing. Then, if all goes well, and ***our*** friend with the blue pencil raises no objection, 1’11 tell you how to build up the frames into a 7-1/4in. gauge engine, “ between whiles.” She will have either link-motion or outside valve gear as desired, brakes, and all the usual impedlmenta, and we’ll call her “ Julia, as she is a relation to the little one. This looks like fulfilling another long-felt want! Anybody wanting a six-coupled engine, can double the frame dimensions of “P. V. Baker,” and use the same type and size of cylinders and motion that I shall describe for “Julia.”



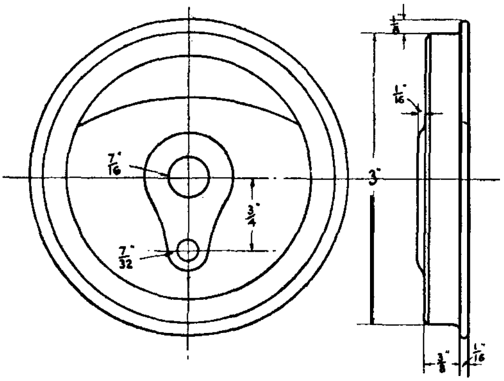
Hornblock and axlebox details

Carrying on with the 3-1/2in. gauger, the next job will be the axleboxes, and these are shown in the accompanying illustrations. They are machined up exactly as described for the “ Lassie ” and dther engines given in these notes ; but thev differ in each having two simple overhead coiled springs resting in drilled pockets, and bearing against the top of the hornblock. The springs should be made from 20- or 21-gauge tinned steel wire wound around a piece of 1/8in. rod held in the three-jaw. Touch the ends on a fast-running emery-wheel after cutting to full length. The springs should just start to compress when the horn-stays are put on. Beginners should note that the axleboxes must not have any fore-and-aft movement ; they should slide easily between the horncheeks, without slackness. They should, however. be allowed a little side movement. so that the-axles can tilt when the engine runs over a bad bit of road, or through wide rail joints or crossing frogs. The hornstays are merely 1-1/2in. lengths of 3/8in. by 3/32-in. flat steel, with two No. 30 holes as shown, and are attached to the hornblock lugs by 1/8in. or 5-B.A. screws. Assemble the whole lot as shown, and jam a piece of 1/8in. square rod, or piece of metal, between each hornstay and axle-box, so as to keep the boxes in ***running*** position while the motion work is erected. The, running position is with the box midway in the hornblock, with a 1/8in. space at top and bottom, the centres of axles being 5/8 in. from the bottom line of frames,

The four-coupled wheels are 3 in. on tread, with 1/16in. flanges 1/8in. deep. The back of the wheel is flush, and the bosses carrying crankpins project 1/16 in. from the wheel rims. They are machined up exactly the same as described for the “ Lassie ” and other engines, the treads being cylindrical, or parallel, except for a slight chamfer at the edge. Beginners should recollect that the radius at the root of flange should not be too small, otherwise the full depth of flange will bear against the railhead all the time, with consequent loss of power, increased friction, wear of rails, and brake effect ; an important consideration when the engine is required to work continually over sharp curves. The less flange friction, the better, both for engine and rails.

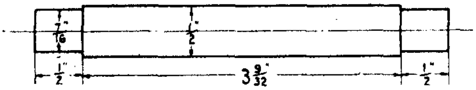
The leading crankpins can be made from 1/4-in. round silver-steel, and the driving crankpins from 5/16in. ditto, the machining and fitting being carried out as for “Lassie.” Note that the driving-pins have screwed ends, 4-B.A. or 5/32-in. by 40, and not plain spigots, as the engine has inside valve-gear. The portion which enters the hole in the wheel-boss must be turned to a tight press-fit, but be careful not to overdo it and split the wheel-bosses. The holes for the pins are drilled in the wheel-bosses by jig, as per “ Lassie ” instructions.

The axles can be turned from)-in. round steel ; ground mild-steel, or ordinary silver-steel is the best material, but ordinary drawn rod may be used if nothing else is available. Failing mound or drawn rod, use black mild-steel of nearest larger diameter available, and turn the whole axle between centres. Centre a piece about 4-3/4in. long ;turn it down to 1/2in. diameter for full length, then reduce the ends to a drive-fit in the holes in wheel-bosses, as per " Lassie " notes, leaving the centre portion 3-9/32 in. between, shoulders. Do the end nearest the tailstock first, then reverse between centres, putting the carrier on the other end. Finally, chuck in three-jaw and shorten the wheel seats to 1/2 in. in length, with a knife tool. Round rod of correct size may be chucked truly in three-jaw, and the wheel seats turned to diameter and length at the one setting.

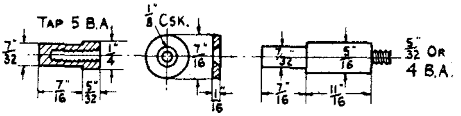


Coupled wheels

The leading wheels can be put on the axle and pressed home right away. Press one on in the vice, poke it through the axleboxes, and put the other on by hand as far as it will go, setting the crankpins at right-angles "by eye." Then remove axleboxes with wheels and axles complete and quarter them as described for " Petrolea." To repeat briefly for beginners, stand the assembly on something level, such as the lathe bed, 'and set the left wheel with the crankpin right down, so that the edge of a try-square blade passes exactly over centre of both axle and crankpins. Put a block or something under the wheel each side, to prevent rolling , and see that the stock of the square lies fair and full length on the bed. Set the point of your scribing-block needle to the centre of the axle , then adjust the other crankpin so that the needle is dead in the centre of it when the crankpin is a quarter turn ahead of the one right down. The wheel can then be pressed home in the vice, and the assembly restored to its place in the frame.



Axle



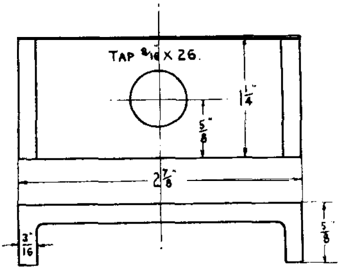
LEADING. DRIVING.

Crankpins

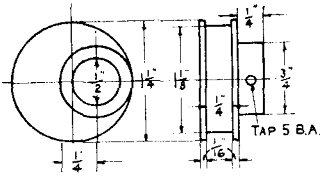
Press one driving wheel on the axle, and put same in place, but only put the other one on by hand, for the time being. Before it is pressed home, the eccentrics and stop collars have to be made and fitted.

Boiler-feed Pump

The eccentric for the pump is the same as described for the " Lassie " a drawing of it being reproduced here, and it is'turned from a piece of 1-1/4in. round mild-steel (piece of shafting does fine) to the dimensions given. The sizes for the pump-stay are also shown ; this may be made either from a casting, or a piece of 1-1/4in. by 3/16in. flat brass bar 2-7/8 in. long, with a piece of angle brass riveted on each end, for attachment to frames. The pump itself is exactly as described for the " Lassie "-the smaller pump, 3/8 in. bore and 1/2 in. stroke ; and if you refer back to the drawings and instructions for that, which appeared not so long ago (page 189, February 21st issue) it will save needless repetition. The only difference is that the eccentric-rod is 1/16 in. longer between centres of strap and eye. The complete pump is erected between the frames, barrel pointing towards rear of engine, and back of valve-box exactly 1/8 in. away from the leading axle. The pump barrel should be set horizontally, so that its centre-line passes through the centre of the driving-axle, and the bottom of the stay should be level with the bottom of the frames. Well, I guess that will be enough to keep " Juliet " builders busy for a couple of weeks or so ; next spasm will be coupling-rods and cylinders.



Pump stay



Pump eccentric

A Co-operative Job

The locomotive shown in the accompanying reproduced photograph shows what can be done when a few club members show the real club spirit in giving practical help and advice to a fellow-member in need of same ; and it gives your humble servant much pleasure indeed to be able to put it on record. A member of the Grimsby and Cleethorpes S.M.E., Mr. A. Grose, was an ardent member of the power-boat section of the club, but became infected with the locomotive microbe ; and knowing very little about locomotives, thought it would be a good plan to acquire an incomplete engine, and finish it off by aid of some of the locomotive fraternity among the members. This idea seemed O.K. and a partly-finished engine was purchased ; but then the fun began! The engine proved an awful washout ; the chassis was very poor, the valve-gear being Marshall's patent radial gear, and far too flimsy to stand up to hard work such as passenger hauling. The boiler was a rivet-and-solder job, with much more solder than rivets, and there were various other imperfections, so that our worthy friend began to feel down in the dumps, and to despair of carrying out his desire. However, he took the pieces along to a club meeting, and the locomotive members held a post-mortem on it, the verdict being that the job could be resurrected by co-operative action. One member took the chassis in hand, and fitted a complete new Joy valve-gear in place of the original Marshall ; another turned a new crank-axle out of the solid ; a third took the boiler in hand, dissected it, salvaged the barrel, put a new firebox wrapper on it, fitted a new inside firebox and brazed up the whole bag of tricks. Meantime our worthy friend himself was not idle. Although he only has a weeny lathe, similar to the one first acquired by young Curly of the 'nineties, he took the smokebox in hand, and turned up a new ring and door, which was " passed for service " by the other members of the locomotive co-operative society. He then turned his attention to the details making new buffers, dummy Westinghouse donkey, brake pipes, screw couplings and other oddments.

The engine was eventually completed, and the members taking part in the resurrection were so enthusiastic to try out the result of their combined efforts, that the trial run was made in a snowstorm, the rails having to be cleared in front of the engine. She responded nobly, performing truly both to the traditions of the old " Brighton," and the gospel of " Live Steam " as preached in these notes and practised by your humble servant. The engine is only 2-1/2in. gauge, and measures 23 in. over buffers ; but the boiler, which is practically " scale " size, with a narrow firebox, steams excellently, and the locomotive hauls a living load in the manner usually observed among good and efficient railway engines. Our friend was so pleased with her performance, and so grateful to the club members for their assistance, that he set to work with a will to finish her off with the requisite blobs and gadgets and a coat of paint ; the result you see in the picture. He apologises for the Stanier chimney and dome, but says they will be replaced by correct " Brighton " type adornments in the near future ; and concludes his letter with the fervent wish that his experiences may give some encouragement to others who may be in similar circumstances. You bet they will; and followers of these notes won't need any invitation to join old Curly in offering hearty congratulations to Mr. Grose on the success attending his endeavours, and also to the willing and able helpers who came to his assistance in time of need. A fine example indeed, of the spirit that ***should*** animate every club in existence ; and a lesson that I sincerely hope will be taken to heart by those who delight in finding fault with the work of others. Yes—there are black sheep in every flock !

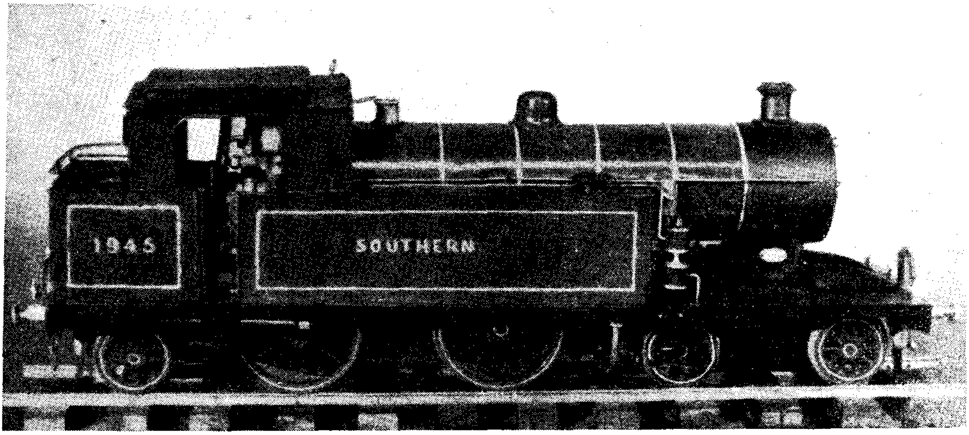


Photo by:] *Many hands make light work !* *[T. J. Warren*

Valve-gear Tip for the "Lassie"

A couple of letters from correspondents asking what is the correct amount of clearance to allow between the die-blocks, and the ends of the slots in the expansion-links, of a Walschaerts motion in full gear, reminds me of a small omission made when describing the Walschaerts gear for the " Lassie." The omission was obvious, but in case any beginners get fogged, I'll call attention to it right here. I forgot to state, when describing the assembly of the expansion links, that the little distance-pieces, or spacers, at top and bottom, should be bevelled off at each end ; so that when the links swing over to their full extent. and the motion is in full gear, the radius-rods will not catch against the corners and prevent full movement of the die-block. I couldn't help a chuckle to myself when I thought of it, because here is a disadvantage of doing the actual job myself! When assembling a link of the pattern specified for the "Lassie," I just pick up a file and proceed to take the corners off the spacers without thinking a blessed word about it, taking the job as a matter of course ; and as I do every job " in my mind's eye " as I write the description of it, I guess that little item was passed over with the same-well, nonchalance, shall we call it ?-as it would have been if I had actually been building up the links instead of giving instructions on how to make them. Anyway, there's no harm done ; and anybody who didn't bevel off the corners, can do the whole lot in two or three minutes, by judicious use of a thin flat file, without dismantling anything. Sincere apologies if anyone happened to led astray !

Reverting to the query, about 1/32in. clearance is enough on a 3-1/2in. gauge locomotive, which will allow for the small amount of die-slip which takes place when a radius-rod is guided by a die-block, as on the " Lassie," or with suspension by a long hanger behind the link, as on the Maunsell 2-6-0's of the Southern Railway. In cases where the radius-rod is suspended from a short hanger ahead of the link, there is more die-slip, owing to the short radius in which the end of the hanger swings ; but as long as the die-block doesn't actually hit the end of the slot in its lowest position, all will be well. The point was also raised about making the slot slightly wider for about 1/16 in. each side, top and bottom, to prevent steps being formed by the die-block at each extremity of its travel: There is not the least objection to this ; full-sized engines have a considerable amount of ***clearance at each*** end of the link, the die-block slightly over-running the gap in full gear. On a little engine with hardened links and die-blocks, there is little fear of wearing steps in the slots ; and anyway, with the valve-gears specified in these notes, the usual place for the die-block, when running, is very nearly in the middle of the link, so that the movement is too small to wear a step during the lifetime of the engine !

Ratio of Ports to Passages

A reader of these notes ordered a pair of finished cvlinders from an advertiser. to be made to mv published specifications ; and refused to accept delivery because the advertiser milled out the passage-ways to the same size as the ports. The advertiser said he did it because there was no sense in having a big port if the connecting passage-way was smaller in cross-section. Several beginners who are aware of this transaction, ask if the advertiser was right or wrong, or the customer justified in refusing the cylinders.

This is a case where the customer was right. The advertiser-and many other people-overlooked the fact that ***the passage-ways are always full*** open, but the ports are not. The passage-ways need to be just large enough to pass the requisite amount of steam in the time available, according to the speed of the engine, and no more. Passage-ways have to be filled and emptied at every stroke, at both ends of the cylinder ; and ***the steam is blown to waste,*** therefore ***a*** cylinder ***with*** huge passage-ways takes twice as much steam, in many cases, as one with passages drilled to my specifications. This is one reason why one or two advertisers-Mr. Simmonds, for instance-cast ports in the cylinders, but leave passage-ways to be drilled.

The reason for the big ports and quick valve-travel, is to enable sufficient steam to pass the edge of the valve, to build up full pressure on the piston head as the crank passes the dead centre ; and if the advertiser and other folk check the amount of initial port opening against the full passage area, they will find the latter is by far the larger. This condition also applies when the ***engine is running*** fast, and well notched up. When the engine is running slowly, and the valves are opening the ports to the extent allowed in full gear, the port opening is more than the passage area ; but this doesn't matter a bean, because the speed of the engine gives the steam plenty of time to get into the cylinder and perform its allotted task, with the absolute minimum of wastage. Time is the deciding factor in the last-mentioned instance.

Ship Modellers' Corner

(Continued from page 492)

and culminating in white for the broken water of the crests and along the sides of the vessel. On the other hand, one may prefer to show the model under stormy conditions. In this case much less sail should be set, in the extreme case cutting down to the six topsails. One of the most effective water-line models I have seen is that of the ***Herzogin Cecilie*** in the Deutches Museum, Munich, showing her under just these conditions, with the figures of over sixty officers, cadets and men on the yards and on deck shortening sail. The model was about six feet long and was a magnificent piece of work. The sea was grey and threatening, as was appropriate, Across the passage there was a similar model of the five-masted ship Preussen with all sail set and on a pleasant sea of blue and green. Both models were very impressive in their different ways. The modeller is strongly advised to experiment, both with the carving and the painting, on a piece of scrap wood before commencing work on the wood which is to form the actual base.

Many water-line modellers, especially sailors, prefer to make their seas in putty, but my objection to it is the smooth, oily effect which seems to result. A wooden sea such as here described has a freshness and naturalness which I have never seen produced by any other means.

That, I think, completes the instructions for making the model of the ***Archibald Russell,*** both with and without sails. I have tried to describe fully all the points which are likely to arise, but if there is anything not quite clear to any of our readers, a letter to the writer, c/o the Editor, will always have attention.

" L.B.S.C."

" Hielan' Lassie's " Smokebox Tube-plate

AS we shall need the smokebox tubeplate to act as support and spacer when silver-soldering the tubes into the combustion-chamber tubeplate, this will be the next job. A circular former is needed, 4-3/16 in. diameter ; although the thickness of both the boiler barrel and the tubeplate is 3/32 in., or 13-gauge. the tubeplate, when flanged, should be slightly larger in diameter than the inside of the barrel, so that it can be turned to a tight fit in same. It is seldom that I have to make a special former for a smokebox tubeplate, as I can usually find an old chuck-plate casting, wheel, or something else of requisite diameter. Cut out a circle of 13-gauge sheet copper to a diameter of approximately 4-3/4in., soften it, and flange over the former as previously described. You probably won't be able to get it on to the inside jaws of your self-centring chuck for turning the flange, as the bottom steps of the jaws will be in the way ; so put the outside jaws in, grip the flanged plate with the flange outwards, and skim off any raggedness left by the flanging operation. Then reverse the plate, and mount it on the outside of the top step of the outside jaws, gripping by the inside of the flange ; this may sound like Pat O'Finnigan's way of chucking it, begorra, but it will be found quite O.K. Turn down the outside of the flange with a round-nose tool, and don't forget a drop of cutting oil; make it a tight fit in the barrel, but not an actual drive fit, or you may damage the smokebox end of the nest of tubes when fitting the tubeplate to the barrel.

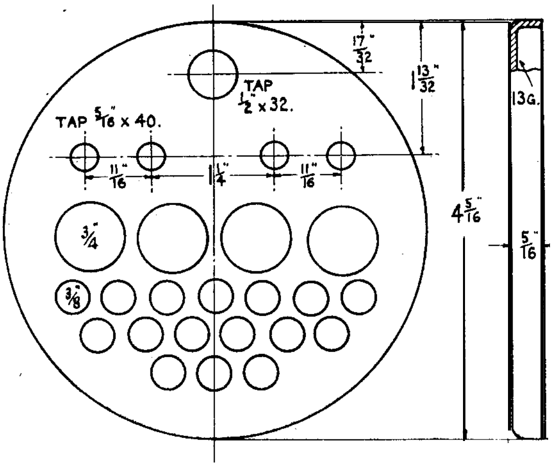
Use the combustion-chamber tube-plate former as a jig for setting out the holes for the tubes. Simply clamp the former to the tubeplate by aid of a toolmakers' cramp, with the semi-circular edge of the former about 1/4 in. or so from the flange of the tubeplate, so that the tubes will be about horizontal. Billy Stroudley used to slope his tubes upward towards the smokebox, and camber them slightly as well, to avoid leakage caused by expansion. The tubes and the boiler had different degrees of expansion. We needn't bother about this on an engine of 3-1/2in. gauge, with the whole boiler and tubes made from the same kind of metal, as the whole bag of tricks expands as one unit.

Poke the No. 40 drill through all the holes in the former, carrying on right through the tube-plate ; then remove, and open out all the holes exactly as described for the combustion-chamber tubeplate, but push the reamer well through each hole, so that the tubes will fit easily this end, and in addition, countersink the holes slightly on *both* sides. This is to allow on one side, for easy entry of the tubes when assembling ; and on the other side, a little trough to fill with silver-solder, and make a perfect job.

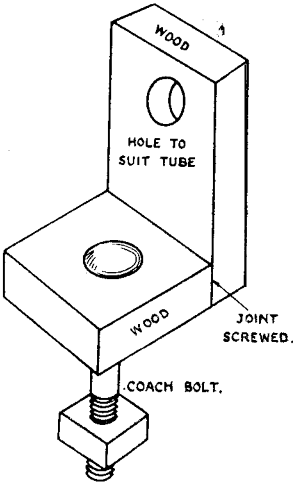
The holes for the steam-pipe, and the longitudinal stays (both solid and hollow) are shown in the accompanying illustration, and need no detailing. Be careful, however, to run the tap through square with the surface when tapping, and recollect that a drop of cutting oil on the tap makes easy work of it.

Tubes

Readers who know of my experiments with boiler tubes may be surprised to notice that the diameter of the small tubes is 3/8 in., as I quoted 11 in. for the maximum efficient length of this diameter ; but one explanation is that they are not fitted direct in the firebox, but the combustion chamber intervenes. Had the engine been an Atlantic or 4-6-0 with a shorter barrel and no combustion chamber, the tube diameter would have been 7/16 in. I needn't go into the whys and wherefores here, but I might just whisper into



Smokebox tube-plate for " Hielan' Lassie "



Steady for turning tube ends

your ears that the provision of four superheater flues also has something to do with it, so we'll leave it at that. Anyway, cut four pieces of 3/4in. by 20-gauge seamless copper tube, and sixteen pieces of 3/8in. by 22-gauge, to a length which will allow them to be squared off in the lathe at each end, and finish to 11-1/4 in. Your humble servant is lucky here, because some years ago a kind friend presented him with a miniature tube cutter, as used by plumbers and gas-fitters. It cuts tubes up to 1 in. diameter, the tube being held between three rollers, two of which are grooved, and one knife-edged. The latter is forced into contact with the tube by a screw with a knurled knob, and if the gadget is placed on the tube, the knob tightened, and the whole doings revolved around the tube a few times, the cut is made clean and square. and needs no turning. Tip for beginners : if your lathe hasn't a hollow mandrel, or if it has one too small to admit the tube, make a little wooden steady, as shown in the illustration, from a couple of bits of wood screwed together at right-angles and held to the lathe bed or saddle by a coach-bolt. Drill it with a drill in the chuck-; you can push it along the lathe bed by hand, as wood drills very easily. Hold one end of the tube to be squared-off, in the three-jaw, and let the other end poke about 1/2in. through the hole in the steady, giving it a spot of oil. You can then use a knife tool for squaring off, without any fear of damaging the tube. Clean the ends of the tube with a bit of fine emery-cloth whilst revolving.

As you cannot get at the under-side of the tubeplate with the blow-lamp flame, and it would be a ticklish job to get the whole issue properly heated if all tubes were put in at once, it is advisable to silver-solder the tubes in two instalments. First put in the four superheater flues and the top row of 3/8in. tubes.They should be a tight fit in the holes in the combustion-chamber tubeplate, and project through about 1/32 in. Then put the smokebox tubeplate on the outer end, to hold them at correct-spacing. Carefully line them up so that they are parallel with the-top and sides of the combustion chamber, and square with the tubeplate. Stand the assembly in the brazing pan, with the tubes pointing skyward, and smear some wet flux right around each tube. As only two rows are in, they are all get-at-able. " Easyflo " is about the best for this job, with its *special flux; failing that, use best grade silver-solder, and powdered borax mixed to a paste with water. Cut the silver-solder into narrow strips, and use the little tongs to apply it. "Easyflo" can be obtained in either strip or wire form ; a personal friend, Mr. T. Heat-n, of Watford, uses the wire, winding it up in the same way as you would wind an axlebox spring, cutting it into single rings, and placing one ring around each tube. This is pressed into close contact with the tube-plate, and the whole lot covered with wet flux. When the job is heated to the right temperature, the rings simply melt into the countersinks, sealing in the tubes perfectly, and that is all -there is to it!

To do the job in the ordinary way, first pile up the coke or breeze all around the chamber, almost to tube-plate level; then get the blow-lamp going strong, and first of all, heat up the tubeplate. When this begins to glow. blow a little on the tubes, but don't keep the flame too long in one place, or you may overheat them and burn the copper. Attend to the thicker super-heater flues first. When the whole lot-end of chamber, tubeplate, and tubes-reach a nice medium red, and the flux has fused, apply a strip of silver-solder to each tube. A little will immediately melt off, and "flash " right around the tube, making a perfect seal. Don't overheat ; you can tell at once if this is happening, by the silver-solder starting to "boil and bubble." Eh-what's that? Yes, I know perfectly well, that the secret of good brazing is plenty of heat but, as before stated, you can have too much of a good thing. The doctor told his patient that a spoonful of the prescribed tonic each day, would ensure a slow but complete cure ; the impatient thought that by taking the lot at-once, it would finish the job much quicker. It did-the verdict was " Death by misadventure." In the present case, the right amount of heat, is the temperature at which the brazing material will melt and flow freely. With " Easyflo," this is a dull red ; with best grade (usually known as No. 1) silver-solder, it is very little higher, just medium red. At the right temperature. the silver alloys with the copper and makes a perfect joint, smooth, even, and free from pin-holes. If any beginner is at all doubtful, drill a 3/8in. hole in any scrap bit of copper, stick an odd end of 3/8in. tube in it, stand it on the coke and have a trial run. Young Curly got a lot of his knowledge and experience that way. Try it in late evening, or in a dark corner (not in your workshop !) and you'll learn how to judge temperature by the colour of the heated metal, better than I could tell you in pages of instructions.

Let cool to black, quench out in pickle, wash off and clean up, put in the two bottom rows of tubes, and ditto repeato the whole process. Beginners will most probably say, why quench out and cool off the lot ; why not put in the other tubes whilst the job is still hot, and save reheating from cold. All right, try it and see how many tubes you get into the hot combustion chamber. If you do get them in, the wet flux will flash off as soon as put on; and even if the job cooled sufficiently, whilst inserting the rest of the tubes, to allow it to be fluxed properly, the oxidation of the metal during the first heating, would effectually prevent the silver-solder " taking," and the job would be a failure. The only satisfactory way, is as described above ; the first pickling removes all the oxide from the first heating, so that the second stage of the proceedings goes through in the approved manner, with reliable results. I hope our more experienced members of the locomotive-building fraternity won't be impatient at these L-card digressions; but I get so many letters from novices, full of complaints about failures, that it really saves time to point out possible pitfalls to them, before they have a chance to tumble in. ***And*** all the novices who are pluckily attacking the " Lassie " job, are eager for full success !

Before quenching the second tube job, as it is

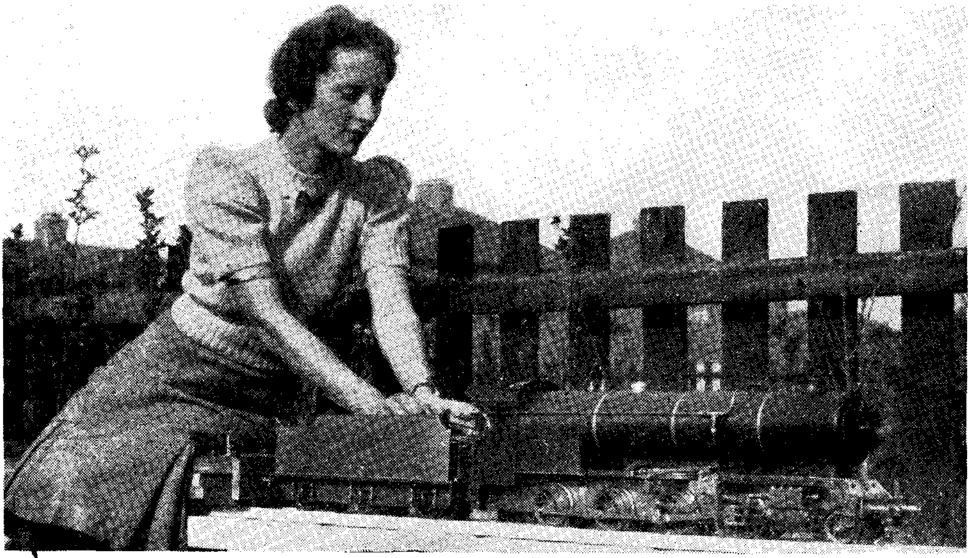


Photo by] *Sharing* his *pleasures* ! [*F. Markham*

cooling to black, carefully take off the smokebox tubeplate, and make the ends of all the tubes and flues dull red. It doesn't matter whether these cool to black or not, before quenching in the pickle ; the object is first to soften them so that they may be properly expanded into the smokebox tubeplate, and secondly to ensure a properly clean surface for silver-soldering. Next week, all being well, I'll tell you how the whole issue is assembled and fixed in the boiler shell. Meantime, here is a tip that I forgot to mention when describing the brazing up of the throatplate. Easy-running strip, when melted, has not the fluidity of melted silver-solder ; and when going around the semi-circular joint between barrel and wrapper, it may happen that the easy-running strip will just fill up the crack between the plates, and not penetrate to the butt strip which is riveted inside. If you run some silver-solder-coarse grade will do-into the crack first of all, this will penetrate and make a sort of inside seal between the plates and the butt strip. something like soft solder does when sweated in with a blowlamp. The crack can then be filled up with the molten strip, after you have run in the fillet under the barrel, and if any superfluous knobs and excrescences show above the crack, just file them flush. This precaution is not necessary if Sifbronze is used with an oxy-acetylene blowpipe ; all there is to be done in that case, is to fill up the V-groove (which I mentioned should be filed around the joint) by the drop-by-drop method as given in previous instructions. This makes the joint stronger than the plates themselves ; and the "ripple " need not be filed off, as it will be covered over by the lagging.

The " Old Firm " Still in Business !

What with the opening of the Malden club's new railway, and the active construction now in progress, by the Birmingham S.M.E., a Campbell Green, of a line approximately 1,020 ft around, plus others either under way or contemplated, we are inclined to forget the pioneer of them all, the open-air club track at Romford. Though this will soon be transferred to a new site, as the present one is required for other purposes, at the time of writing it is still in active service ; and I am in frequent communication with various members who are certainly not failing in their enthusiasm for the little iron horse. The genial and energetic secretary himself is building a hefty job in 3-1/2in. gauge, to wit, a L.M.S. 2-6-4 tank engine, and is fortunate in possessing a wife who is just as keen on locomotives as he is. Mrs. Constance Markham is a skilful driver-here you see her on the job-and she sends a personal message to all other wives of locomotive builders, viz., " Try to take an active interest in your husband's hobby, or at least show tolerance, understanding, and helpfulness., whether by thought or action. Harmony in his world of little engines, is the best guarantee of happiness in your home." With those sentiments your humble servant heartily agrees.

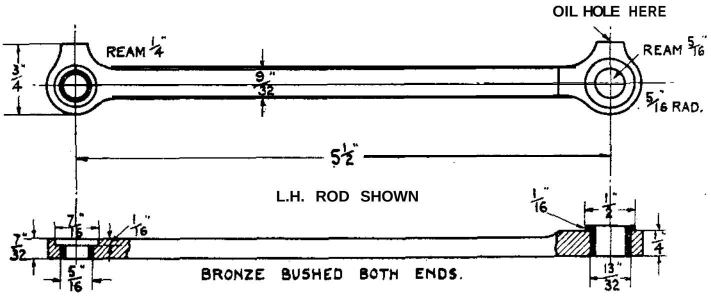
I mentioned in a recent note that the "official" speed record of just over 10 m.p.h. was held by Mr. S. H. Carr's "Fayette," but the track manager, Arthur Chapman, says the same builder's " Mary Ann " (J.39 L.N.E.R. 0-6-0) equalled that speed when competing in the Henderson trials at Romford, in 1939. She was hauling Stan Carr himself, plus a load of lead weights. This is some going for an 0-6-0 goods engine, and just goes to show what can be done by early admission and free exhaust. The engine was built to the instructions given in these notes a long time ago ; I built the original engine of the series, from which all the dimensions were taken, and she is still in existence at

Taunton, going strong the last time I heard of her. Incidentally, I hear from the Malden club that one of the fastest engines yet seen on their road is a “ Molly,” another 0-6-0 built to your humble servant’s instructions. The fastest engine in 2-1/2in. gauge which has performed on the Romford line, is yet another “ Live Steamer ” (L.M.S. 5XP “ Olympiade” type) owned and driven by Eddie Bailey, which knocked up 11-1/2 miles per hour hauling Eddie’s eleven stone of live meat. That is some going, too, as anybody who has done it even on 3-1/2in. gauge will fully agree ; and although the run was not “ officially ” timed, it is quite authentic.

Arthur Chapman himself is building a “ Hielan’ Lassie ” with ***four*** cylinders and the eight-beat setting, using slide-valve cylinders, Baker gear outside, and Holcroft inside; that looks like being the “ Queen of the Lassies ! ” Another interesting job will be John Clancey’s L.N.E.R. K3 2-6-o. Locomotive-building has done quite a lot for John ; through sustaining “ personal war damage,” he developed cerebral trouble which has rendered him unconscious for sometimes as much as 36 hours at a stretch, yet he carries on, and has built a gauge “ 0” coal-fired 4-6-2 which is the great delight of his small son. Space does not permit a full list of the other engines now under way ; but the workshop superintendent, Bill Killey, says that Stan Carr has offered a 3-1/2in. Drummond lathe on indefinite loan, and it is now being installed in the workshop, to help matters along. Though, alas ! some of the pioneers of the Romford club track have passed on-one was killed in an air raid at his own front door-George Larter and a few others are still carrying on the good work. Here’s wishing the best of luck to the “Old Firm ! ”

Coupling-rods for “Juliet ”

We’ll hang the tail lamp on this week’s notes by giving a sketch of the coupling-rods for “ Juliet.” No special description is needed, just follow the instructions given for the “Lassie” and other engines previously described. The rods themselves are made from two pieces of 3/4in. by 1/4in. mild steel bar, either milled, or sawn and filed to shape. Anybody who feels energetic can put a flute in, if he so desires ; it makes the rods look pretty, but doesn’t have any effect on the working. “ Old Billy ” never specified fluted rods, he just had them painted ; and the cleaner boys used to scour up the bosses and the crankpins like silver, which effectively “ set off” the maroon colour. Engine-cleaning can now be reckoned as *one* of the lost arts in these “ enlightened ” days ! Turn the bushes out of phosphor-bronze drawn rod, if possible ; if not available, use hard brass. The hole for the bush in the leading end is drilled 5/16in., and in the driving end 13/32-in. The bushes should just project the weeniest bit, not more than 1/64 in. at the outside, on the backs of the rods, to keep them from rubbing over the full face of the wheel bosses. The recess in the leading end is pin-drilled 1/16 in. deep, to suit the retaining washer.



Coupling-rods for “ Juliet ”

Petrol Engine Topics

(Continued from page **528)**

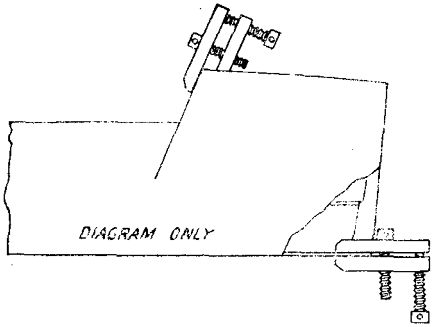
argument as to which was correct, “ teaspoonsful” or “ teaspoonfuls.” Personally, I don’t care a soup ladle which is correct so long as I understand exactly what is meant by either term-which, incidentally, is not a very precise one from the technical point of view. Just recently a discussion has arisen as to the correct way to spell “ carburettor.” I have always used the spelling given, following the precedent set by many leading authorities and technical journals on automobile engineering. Bnt I know that other and equally competent authorities spell the word with a final “ er ” ; and no doubt they are equally correct. On further investigation, however, I find there are no less than five different ways of spelling the word which have been used in publications issued in the English language ; but you or I understand exactly what is meant, whether. it is spelt carburettor, carburetter, carborator, carbureter, or even carburateur ! Any further argument on this and other similar variations of spelling may safely be left to the pedants.

" Hielan' Lassie "

By "L.B.S.C."

How to Fit Firebox to Shell

BEFORE starting on the assembly job, beginners would be well advised to take a good look at the longitudinal section of the boiler shown in the October 24th issue. If you have not bent out the front of the firebox plate as shown, but have left it straight, as given for an alternative, a piece of 1/4in. square copper rod, cut full length between the throatplate flanges, should be fitted at the bottom of the throat-plate. Both throat-plate and rod should be well cleaned. If the firebox plate has been bent outwards as shown, clean the contact-surfaces, also the tops of the girder stays and the inside of the wrapper sheet. Lay the boiler shell on the bench on its back and slide the firebox and tube assembly into it until the front plate of the firebox comes up against the throat-plate, or piece of copper rod according to which method of construction was used. Put a toolmaker's cramp on at each end, to hold the parts together. Now see if the flanges of the girders on the firebox are in full-length contact with the wrapper ; this is important, and if they need any adjustment to get them in the required position, do this right away. Also, see that the firebox is central in the shell ; that is, an equal distance at each side, between the side of the firebox and the adjacent wrapper sheet. Put another toolmaker's cramp over the edge of the wrapper and one of the girder stay flanges to keep the lot in close contact. Put a few 3/32-in. copper rivets along the joint between throat-plate and firebox plate, at about 1/2 in. centres, to keep the parts in close contact whilst brazing. The clamps can then be removed.

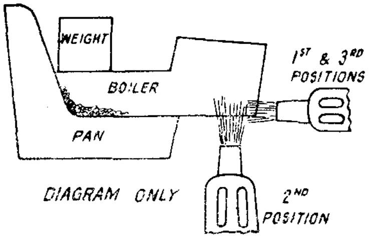


How to assemble firebox in shell

Drill a few holes with No. 41 drill, say, at about 1/2 in. centres, through wrapper and crown-stay flanges ; file off any burrs inside and put a few 3/32-in. copper rivets through these joints also. Personally, I put these rivets in by the aid of a strip of metal with a notch in the end like a distant signal ; the rivet is jammed in the notch, and is held quite tightly enough to permit inserting, even to the extent of pushing past a slight burr. For a dolly I use a piece of 3/4in. by 1-1/4in. iron bar held horizontally in the bench vice, and, to prevent the bar slipping down, or having to wrench the vice handle hard enough to strip the screw, I just take out one of the inset jaws (removed by taking out two screws) and rest the bar on the ledge which supported the jaw. Just a moderate pressure of the other jaw on the bar then holds it quite firmly. When the rivet-shank appears through the hole on top of the wrapper, put your finger against it, pull away the " distant signal," slip the wrapper over the bar-but don't let the rivet slip out, or the dictionary of railroad Esperanto may need yet another addition !-and then " head " the rivet with the ball end of the hammer-head. No need for either counter sinking or snapping the head, as the lagging will cover it ; but take care not to deface the copper, all the same ! Ditto repeato until all the rivets are in and the firebox is firmly held in position by throat-plate joint and stay-flanges ; then turn your attention to the front end.

How to Fit the Smokebox Tube-plate

The flange of the tube-plate and the inside of the barrel, also the tube ends, should be quite clean. Insert the tube-plate flange first ; this is the opposite ***way*** to full-size practice, but the big engines usually have the smokebox tube-plates riveted in. We need no rivets here at all. Very carefully tap the tube-plate down until it almost touches the tube ends ; then, with a wooden skewer or a blacklead pencil, line up each tube with its respective hole in the tube-plate. The firebox ends of the tubes will be quite soft by virtue of the silver-soldering job and will readily yield to gentle coaxing. When all are nicely in line, tap down the tube-plate until all the tubes project through the holes about 1/32in. A taper drift is now needed to expand the tube ends to a tight fit in the holes ; a piece of g-in. round steel can be tapered off like a drill-shank for the small tubes, and a larger diameter piece for the flues ; or you can use one big piece tapered down sufficiently for the lot. I have a few tapered tool shanks (relics of the 1914-1918 world insanity) which are hardened and polished ; they make fine drifts. Grease the drift and drive it into each tube in turn ; give it a tap sideways if it tries to stick. The lot is then ready for silver-soldering- or brazing ; meantime, smear some wet flux along the top of each girder flange inside the wrapper for its full length, both sides.



How to braze crownstay flanges to wrapper

The Next Brazing Operation

When doing the joint between tube-plate and barrel, Sifbronzers won't need any extra precautions, the job being done by the drop-by-drop method already described ; but brazers will need the following easy rig-up. Get an old tin tray or box lid, or knock up a shallow tray, about 8 in. square, from a bit of sheet iron ; doesn't matter how rough it is. Cut a hole in the middle big enough to admit the boiler barrel ; up-end the boiler and put the tray over it. about 3 in. or so down. If not tight enough to "stay put," prop it up with a couple of bricks or tiles or anything that may be handy. Pile some coke or breeze in it around the barrel to the level of the tube-plate. Put some wet flux all around the circumferential joint, and also around the tubes, and plug the tube ends with little wads of asbestos flock or string, pushing same about 1/4 in. down. Put some little bits of silver-solder among the tube ends (Easyflo or whatever you are using) or else use Mr. Hearn's wheeze of rings of Easyflo wire.

Now get busy with your blowlarnp and heat up the whole boiler end, coke and all, to dull red ; then concentrate on one noint of the circumferential joint (I'm getting fond of that word, by the look of things !), blow it up to bright red, apply spelter stick as described in first operation, and work your way right around. Don't forget that a taste of coarse-grade silver-solder acts as a fine " starter " if the brazing material is a bit shy of melting. Keep the heat well up, and you'll find that a nice even fillet can easilv be made rieht around the whole circle. Sometimes the whole tube-plate and tube ends will glow dull red whilst doing the above job, and the silver-solder around the tubes will start melting of its own accord ; if not, play the flame direct on the nest of tube ends until the silver-solder has melted and formed a ring around every tube. Don't forget to apply the scratch wire if there is any sign of bubbling. otherwise pinholes may result.

Next, quickly knock off the small tray, and lay the boiler on its back in the brazing-pan, with the wrapper overhanging the edge. You will probably have to put a brick or something on the barrel, to prevent it tipping up. Lay a strip of coarse-grade silver-solder each side of each stay flange, and close to it. Blow the flame partly inside and partly underneath, until the stay flanges and wrapper glow dull red, then blow full pressure underneath, on to what would be the top of the wrapper if the boiler were right way up. This will melt the silver-solder strips and start them running. In the days before I took to oxy-acetylene and Sifbronze, I used to do this job with two blowlamps, using my big five-pint underneath and blowing on the inside with the smaller one-pint ; this made the silver-solder run like water, and then I used **to** feed in some " Lafitte " strip until there was a big fillet each side of the crown-stay flanges. Eh ? Oh, no, I'm just a human being, not a four-handed gorilla, nor an octopus ! The big blowlamp was just propped up in position with anything handy, leaving both hands free, one for the small blowlamp and the other for manipulating the small tongs holding the strip of spelter. I often wished I ***did*** have more than two hands, and it's a good job I can use both with equal facility when working. I learned that trick in the far-off days when I had my long curls. Anyway, to do it with one blowlamp, just get the wrapper hot enough to make the silver-solder run, then shift the lamp so that you blow on the end, the flame going partly inside and partly outside, like blowing on the throat-plate flange at the bottom corner ; this should keep the whole lot hot enough to allow some easy-running strip to be melted in along with the silver-solder, to form the necessary fillet on both sides of each crown-stay girder. Critics of my method of crown staying always insist that the flanges will tear away from firebox and wrapper ; with a spelter fillet each side, this is impossible, as they are the strongest part of the whole job and, if properly done, the copper sheet itself would tear away before coming adrift from the flanges.

Let cool to black and repeat the pickling and cleaning process ; and be mighty careful of splashes. The boiler is now becoming a tidy handful, and it is easy to let it slip when " baptising " it in the pickle-bath. I have not forgotten that we didn't do the throatplate-to-firebox joint ; that is done on the final job of brazing the backhead and foundation-ring. The next job will be fitting those parts; and all being well, will form the subject of the next instalment.

" Juliet "

Valve-gear

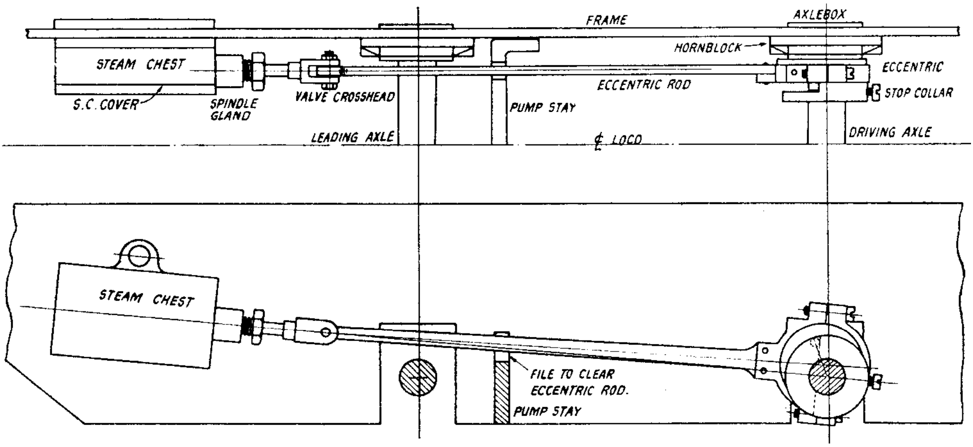
I hope builders of " Juliet " won't think I have forgotten all about cylinders, and am expecting the engine to run on her reputation, like the well-known automobile which finished its journey after the engine dropped out ; but as you can't press on the driving wheels until the eccentrics and stop-collars are mounted on the axle, and it only needs two straps and rods to complete the valve-gear, we might as well finish the job and be done with it ! Then, when the cylinders are made and erected, all you have to do is to put a pin in each valve spindle fork, set the valves, couple-up your tyre-pump, and enjoy a foretaste of the reward that sweetens labour.

Both eccentrics and stop collars are just kiddy's practice jobs. An odd end of 1-1/4in. mild-steel shafting is the best thing you could have for the eccentric-sheaves, or tumblers, as they are usually known among enginemen. Simply chuck in three-jaw, face the end, turn down 1/4in. length to 1-1/8 in. diameter, and part off to leave a 1/16in. flange. Beginners, take care to get the smoothest possible finish. The tool marks will indicate the true centre. Scribe a line right across the tumbler, cutting through the centre ; on one side of it make a centre-pop 3/16 in. away, and on the other 5/16 in. awav. Drill them both No. 72 and be carefu that the drill goes through dead square. Far and away the best plan for a beginner would be to mark-out on the flange side, chuck in four-jaw with the centre-pop for the pinhole running truly, put a No. 32 drill in the tailstock chuck, and poke it straight through ; then shift the tumbler until the pop for the axle hole runs truly, put the No. 32 drill through that, then open out with a 1/2in. drill in the tailstock chuck. If your tailstock won't take that size, use the biggest it will take and open out with a little boring tool until a piece of 1/2in. round steel just slides in without shake. This gives more accurate results than putting the big drill in the three-jaw and the work against a piece of wood on the tailstock drilling-pad. Wood isn't always parallel both sides ! If you have a bench or pillar drilling-machine, put the eccentric in the three-jaw, take the chuck off the lathe and set it on the drilling-machine table, as an alternative to chucking in the four-jaw. Drill in the usual way, the chuck acting as a circular machine-vice. Drive a piece of 1/8in. silver-steel into the small hole, file it so that it projects barely 1/8 in., and that's that.

For the stop collars you can either use the 1-1/4in. steel rod or a piece of 1-1/8in. brass rod. Chuck in three-jaw, face, centre, drill first with No. 32 or 1/8in. to about 5/8 in. depth, open out with a 1/2in. drill, and part off two 1/4in. slices. A segment of each is milled, or sawn and filed away, as shown. Drill a No. 40 hole in the thickness remaining and tap it 1/8in. or 5-B.A. for a set-screw.

Fitting Eccentrics and Quartering Wheels

The pump eccentric goes in the middle of the driving axle ; put a stop-collar each side of it, and then the tumblers, flanges outwards, the axleboxes between them and the wheels. If you have already pressed on one driving wheel, "thread " the axle in the following order : axlebox, eccentric with flange next box, stop-collar with gap next pin, pump eccentric (boss can be either side), stop-collar with gap away from pump eccentric, tumber with pin next stop-collar, axlebox, and the other wheel. Set the crankpins at right-angles as near as you can " by eye " ; then stand the assembly on something level (lathe-bed will do) with a chock each side of wheel to prevent rolling. Set a try-square alongside one wheel, and adjust wheel so that edge of blade passes over centres of axle and crankpin. Set the needle of your scribing block or surface gauge to the centre of axle on opposite side, and adjust wheel on axle until centre of crankpin is at same height ; then press the wheel home. The whole assembly can then be re-erected in the frames and the homstays replaced. If you haven't already quartered the leading pair of wheels, do it now, and the coupling-rods (details already given) can be put on " for keeps." With the axle boxes in running position-that is, with a bit of 1/8in. rod jammed under each box, between it and the hornstay-the wheels should spin freely without any sign of the rods binding. If they bind, you haven't got the quartering correct on both pairs of wheels, and the remedy is to shift one wheel slightly on its axle until the rods run freely. When O.K., drill a hole about 3/8 in. deep with No. 32 drill, half in axle and half in wheel boss, and drive in a stub of 1/8in. round steel, to act as key in each wheel. File off flush with boss. This eliminates any tendency for the wheel to shift on the axle, but doesn't interfere in the slightest with the easy removal of the wheels, should it ever become necessary, e.g. for re-turning treads after wear.

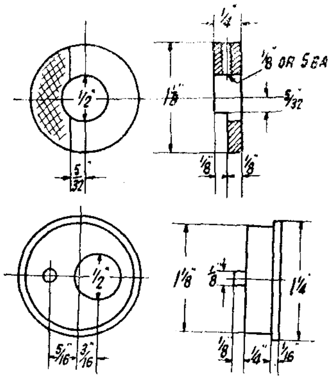


Valve-gear for " Juliet "

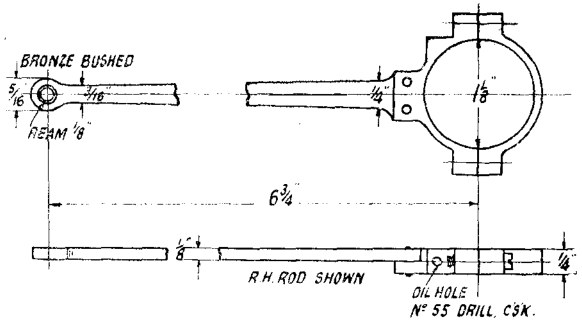
Eccentric-straps and Rods

Eccentric-strap castings as specified for my G.W. " 1000" and engines of similar size, are available from our advertisers, and are machined up as fully described for "Petrolea." Briefly, clean with a file, centre-pop and drill lugs through with No. 40 drill, and saw each strap in half, using vice top to guide sawblade, and marking. each pair of lugs so that they can be replaced " as you were." Smooth off saw marks, tap the lugs on the rod half 1/8in. or 5-B.A., and open those on the plain half with No. 30 drill. Screw the halves together, chuck in four-jaw with the hole (now oval) running as truly as possible, and bore to fit exactly on sheaves. Face one side whilst still in chuck, and the other with the strap mounted on a stub mandrel in three-jaw. The lug for attachment of the eccentric-rod is sawn and filed or milled to half its thickness, and don't forget one has to be milled on the right-hand side and one on the left, otherwise you will have one eccentric with the oil-box upside down, and I just hate to imagine what the driver would say when he went underneath with his oil feeder !

The eccentric-rods are filed up from 1/2in. by 1/8in. mild-steel to the shape shown in the illustration. They are attached to the lugs on the straps by a couple of 1/16in. iron rivets, and you



Stop-collar and *eccentric*



Eccentric-strap and rod

can solder them as well, as a precaution against the rivets working loose. The other end is drilled 3/16 in. and has a bronze bush squeezed in, said bush being drilled No. 33 in the lathe before parting-off and reamed 1/8 in. after being pressed home in the eye of the rod. Put the straps on the sheaves with the oil-holes uppermost and the rods nearest the frames, as shown in rhe plan view of complete gear, and file a clearance each side in the upper part of the pump stay, to allow the rods to line up with the centre of the openings for steam chests, plus a little for the up-and-down movement of the rods when the engine is at work. The correct adjustment of the stop-collars cannot, of course, be made until the cylinders are erected, and I'll tell you how to do it later on. Meanwhile, a word in season.

I learn a dickens of a lot from my correspondence, and have been informed by many beginners, especially those who are newly-joined club members, that the loose eccentric valve-gear is not a " proper " gear, and only fit for toyshop productions. Nothing could be farther from the truth. As I have explained, this gear, out of all the two-hundred-odd gears that have been devised to operate the valves of a locomotive or stationary steam engine, is the only one that will give equal port openings at each end of the cylinder in both directions. With one solitary pin-joint between the eccentric and valve, wear is indefinite, and accuracy of setting retained ; and for an engine of the type we are building, I say unhesitatingly that it cannot be beaten. The fact that you have to push the engine to reverse it is of no moment on a continuous track ; and on the sharp curves of a suburban back garden, with a good load behind the engine, the fixed cut-off point which I shall specify, with adjustment of regulator opening, will give results as economical as a link-motion notched up with a wide regulator opening.

At the same time, for a shunting job, such as running up and down a short straight road, a lever-operated reversing gear would be more handy; and on a long continuous road with easy curves, free from the hard " collar-work " and continual flange-grinding of the garden line mentioned above, a very early cut-off would prove more economical in fuel and water. Therefore, if anybody wishes to build the engine with a full link-motion, I shall be only too pleased to give the necessary alterations. I strongly recommend all beginners to fit the loose eccentric gear as described ; then later on when they have gained experience both in construction and operation, they can, if they so desire, easily add the extra parts required to convert the gear to link-motion. The next instalment will deal with the cylinders.

For the Bookshelf

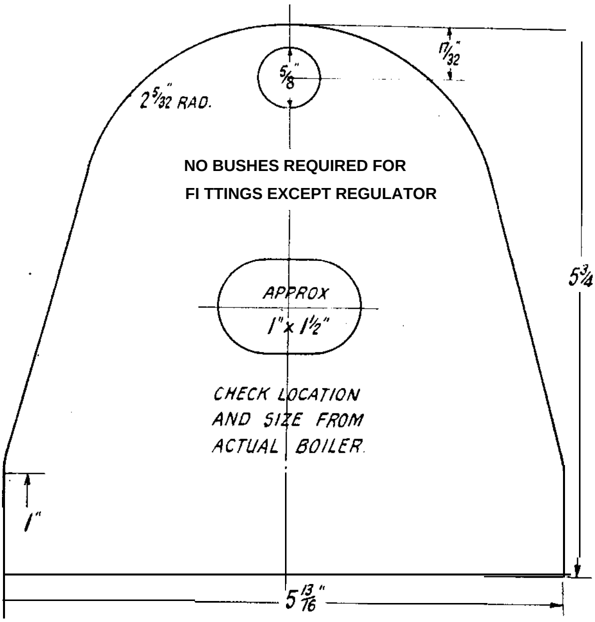
Trigonometry Made Plain By G. P. Rawlings. (London : Percival Marshall and Co. Ltd.) Price 5s. od. net.

A working knowledge of trigonometry is useful, if not essential, in the workshop as well as to the technical student ; and here is a lucid little textbook that should command a wide demand. It avoids the usual fault of plunging straightway into a learned dissertation ; but it leads the reader, step by step, by way of much useful groundwork, up to a clear explanation of what trigonometry is. Then, and only then, does it give any information upon how trigonometry can be practically applied; and many readers may be surprised-to learn that its application covers such varied subjects as : Workshop drawings, mechanical engineering, map making optics, radio, mechanics and navigation. The author's style of writing is clear and very easily understandable, with the additional advantage that the book is obviously the result of practical knowledge of the subject.

" Hielan' Lassie " By "L.B.S.C."

Alternative' Boiler Shell

AT the time of writing, I am getting large-sized tales of woe from all quarters, various " Lassie " builders complaining that they cannot get any 4-1/2in. diameter copper tube for the boiler barrel. On making enquiries from some of our advertisers, they say the wholesalers are out of stock, and one in particular says that the earliest promise of delivery he has so far received, is six months ahead ! The blame is placed on the export craze, the demand for copper tubes in manufacturing industries, and various other contributory factors ; but whatever the cause, the fact remains that the tube is not forthcoming. The only thing for builders who have completed the chassis and wish to carry on right away, is to seek alternatives. The most satisfactory one is to build up the barrel and firebox wrapper from a sheet of 3/32-in. copper, making the whole lot in one piece, in a manner somewhat similar to the method described for the combustion chamber and firebox. This is easy enough to mark-out. Set out on the sheet of copper, the outline of the wrapper as given with the first boiler instalment ; and at the front end, add a section 14-7/8 in. long, and 14-1/2in. wide, cutting the whole lot out in one piece. First, bend as described for the wrapper, then continue bending the front projection into a complete circle with about 3/8in. overlap. Put some 3/32-m. copper rivets along the seam, at about 1/2in. centres. Coax the barrel part into a true circle, then fit the throatplate exactly as described for the combined tube-and-sheet boiler shell as first described. After brazing in the throat-plate — there won't be any upper semi-circular butt-jointed seam to do in this case-lay the shell on its back in the brazing-pan and go along the seam under the barrel, starting from the smokebox end. A taste of coarse-grade silver-solder, if applied before the spelter, will sweat clean through the seam, and the finished job will be as good as one with a barrel made from tube.



Backhead for " Hielan' Lassie's " boiler

Some readers have asked if they can use different sizes and gauges of tube, such as the 4-3/8in. by 16-gauge specified for " Maisie's " boiler. This can be done within reasonable limits. A 4-3/8 in. by 16-gauge seamless copper tube will stand 80 lb. working pressure, and this will be enough to permit the " Lassie " to astonish the natives. The upper part of the firebox and combustion-chamber might have to be made a shade smaller, to maintain the given clearance between shell and "innards," and the given thickness of sheet material should be adhered to ; otherwise there is nothing to fret about. If a piece of larger tube is available, it can be used, with the firebox and combustion-chamber as given. The chimney and dome might be a little flatter, to keep to the load gauge.

Steel, or a combination of steel and copper, have been suggested, but I wouldn't advise a steel boiler unless it was Sifbronzed throughout, and then heavily tinned, or else close-riveted with steel rivets and then galvanised inside and out. It is fatal to use galvanising in conjunction with copper tubes, or brass brazing, as the copper and zinc combination would turn the boiler into an electric battery, and pitting, corrosion and finally rotting, would follow. Personally, I'd rather wait until there are supplies of copper available.

Backhead and Foundation Ring

Anyway, for those who have the material, the next job is to fit in the backhead and foundation ring. An outline of the backhead is given here ; the only bush necessary, is the one for the regulator gland, as the Q-in. metal is thick enough for the fittings to be screwed directly into it. Lay the former on a piece of 1/8in. or 10-gauge sheet copper, and scratch a line all around, except at bottom, about 5/16 in. away. This is cut out-you'll have to saw it, and trim any irregularity with a coarse-cut file-then annealed and flanged as described for the other plates. Beginners will be pleased to find that flanging +-in. material is no more difficult than the thinner sizes. When finished, don't forget to go over the flange with a file. The hole for the regulator bush is 5/8in. diameter ; first drill a small hole, 1/8 in. or 3/16 in., at 17/32 in. below top of flange, measured at the bend ; the flange isn't at right angles to the plate at the top, owing to the backhead sloping when in the boiler shell. Open out, the hole with a 5/8in. drill; or if you haven't one, use the biggest availible, and file to size. The hole doesn't go straight through, but on an angle, which you need not bother about until the backhead is fitted into the boiler shell. The exact angle can then very easily be seen.

Measure the distance from the inside of the top and sides of the wraouer. to the top and sides of the firehole ring ; transfer the measurements to the backhead, mark out the location of the hole, getting the exact size and shape from the lip of the ring itself, then cut out the piece. Leave it a little undersize at first,then offer " up " the backhead. as the shopmen would say. and see how the hole matches up with the lip of the ring. If any correction is needed, you can see at a glance, exactly which side, or top or bottom. File the hole to correct size and location, insert the backhead in position, with the lip sticking through the hole, then beat down the liu. outwards. same as on the inner firebox. If a piece of iron bar is placed horizontally in the bench vice, and the boiler placed over it, with the inside of the ring resting on the bar, it will provide adequate support whilst the beating-down is in progress. Don't forget that lip and edge of ring must be well cleaned ; and a little wet flux smeared around it before beating down, would assist in the brazing job. No rivets or screws are needed around the wrapper-to-flange joint, merely see that the plate and flange are in close contact all around. If they are-not,, teach them manners by aid of the before-mentioned carpenter's mallet.

The foundation-ring is an easy job, being merely three pieces of 1/4in. square copper rod inserted between the firebox sides and wrapper, and the end of firebox and the backhead. Fit the latter first, making the piece of rod fit tightly between the flanges ; put a few 3/32-in. copper rivets clean through the lot. to hold the rod in place, and keep the plates'in contact with it. The side pieces are then fitted and secured same way. Don't forget that clean joints are essential. If there are any interstices left at the ends, plug them with slivers or splinters of copper, so that the brazing spelter won't run through and form stalactites inside the water space. Sifbronzers won't need to do that, as Sifbronze doesn't form the thingammies mentioned, it just fills up the cracks without any assistance ; in fact, it makes the best job when it has a crack to run into, and fill up.

If you have a 5/8in. parallel reamer, poke it into the hole for the regulator bush, and whilst turning it with a tap-wrench on the shank, force it down so that it lies parallel with the boiler barrel. The bush can then be turned up from a bit of 7/8in. thick tube, or copper or bronze rod. ***Don't use brass, or*** in all probability you will find, when brazing in the backhead, that it has performed the ghost act, and vanished. The actual turning is just a kiddy's practice job ; chuck the rod in three-jaw. face the end. turn down 3/16 in. length to a'tight fit in the hole in the back-head, and part off to leave a flange 1/8in. in thickness. Reverse in chuck, centre, drill a 1/8in. pilot hole, open out to 29/64 in., and tap 1/2 in. by 32, or 26. Slightly countersink the end, skim off any burring, and fit the bush to the hole in the backhead. as shown in the longitudinal section. Drill'the holes on top of the barrel for dome and safety-valve bushes ; make the bushes, as described above, to the sizes given on the drawing mentioned, and fit them. We are then ready for the final braze-up.

" Juliet "

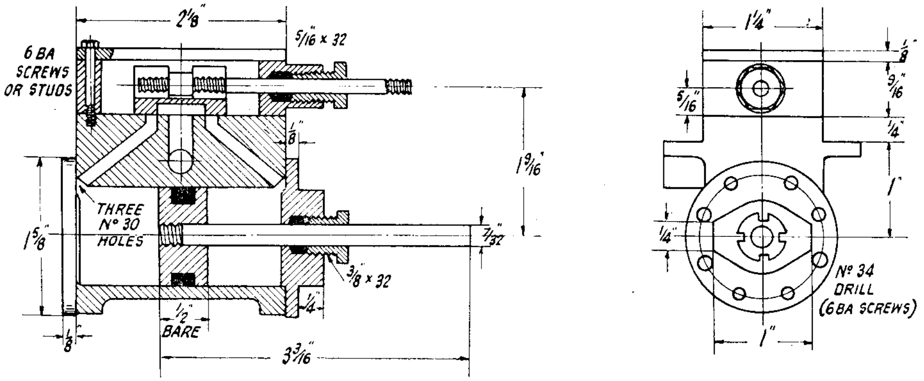
Cylinders

These cylinders are of exceedingly simple pattern, being merely the old type of stationary-engine cylinder plus a flange at top and bottom of the port block, for attachment to the locomotive frames. The drawings are self-explanatory, and can be understood by the rawest of tyros and novices. The cylinder castings are machined up pretty much the same as described for the " Lassie " and other outside-cylinder engines in this series. Clean up the port-face roughly with a file, and mount the casting, port-face down, on an angle-plate attached to the face-plate, with a bar across the back of the casting, held down bv a bolt at each end. Set the bodv of the cylinder parallel with the lathe bed, and the core-hole running truly, then with a round-nose tool crosswise in the rest, face off the flange. Next, with an ordinary boring tool, bore out the core-hole as described for the " Lassie," taking out a good " bite " for first cut, to remove the skin. If you have a I-in. parallel reamer, bore until the "lead " at the end of it will iust enter the hole ; then ream as per " Lassie " instructions. If your lathe isn't big enough to let the reamer go well through, remove-the casting from lathe to bench vice, and put the reamer carefully through with a big tap-wrench clamped on the shank. If you haven't a reamer, bore out to r-in. diameter, and take a couple of traverses through the bore ***without shifting the cross-slide.*** This will make up for any springing of the tool. Use the self-act, if your lathe is a screw-cutting one ; if it only has a plain slide-rest, I described fully, how to adjust this for perfect truth, a little while back. Briefly, put a piece of brass rod about 3 in. long, in the three-jaw, take a fine cut over it, and check diameter each end with a " mike " or calipers. If the mike shows an error of less than half-a-thousandth, or if you cannot detect any difference in the feel of the calipers at each end of the cut, the top slide is all right for cylinder boring ; if not, adjust and try again.

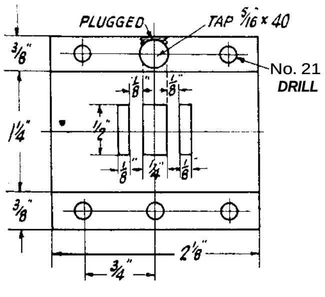
The second flange is turned and faced, with the cylinder mounted on a stub mandrel (bit of brass rod turned to fit bore tightly) held in three-jaw. The port-face is machined off with the cylinder up-ended on the angle-plate, secured by a bolt through the bore and a big washer each end, as per " Lassie " instructions. The contact face of each flange above and below the port block, can be cleaned up with a file, unless a regular milling machine is available, in which case simply hold the casting in the machine-vice on the miller table, and run it under a suitable side-and-end cutter on the arbor. They could also be done on a planer or shaper, using a square-ended tool in the clapper box.

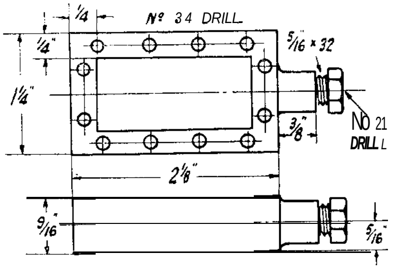
Ports and Passages

One or two of our advertisers will probably supply cylinder castings with ports cast in ; and if the edges are straight, they need not be touched. The ports in the cylinders for " Bantam Cock " which I am now building (along with old " Grosvenor,." the big-wheeled Brighton single, as a parallel lob) were clean and true, and needed no attention whatever. These cylinders will only require the three No. 30 holes drilled into the ports from each end flange, as shown in the sectional illustration, plus the bevels filed in the edge of the bore, to allow passage for steam in and out of the cylinders, If the ports are not cast ***in,*** mark out and cut them as described for " Lassie." Beginners who have no vertical slide for their lathe, can drill three or four small holes on the marked-out location of each port, and chip them into correct shape by aid of a little chisel, home-made from a bit of 1/8in. silver steel. A similar, but larger, chisel with an edge about 3/8 in. long, does fine for cutting a sharp line along each port edge.



Section, end view and portface of "Juliet's" cylinder



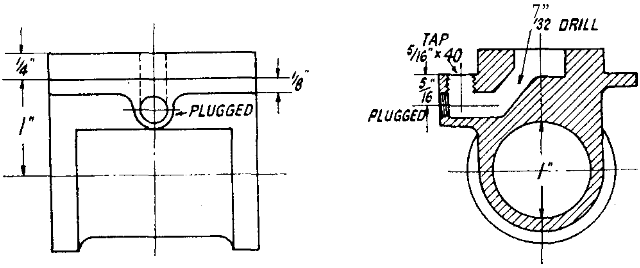


Steamchest

The " entrance to the way out " for exhaust steam is easily made. On the casting, in the middle of one side, you will find the flange extended to form a boss. Centre-pop this, as shown in the plan view of the casting, and drill down 5/8in. deep with 7/32-in. drill. Tap the end 1/4in. by 40. Now put the drill down into the corner of the exhaust port, and drill diagonally into the previously-mentioned hole ; see cross-section. In the middle of the flange, on the side which goes next to frame, centre-pop and drill a 9/32-in. hole, breaking into the first one ;tap 5/16in. by 40. Put a little screwed plug in the hole in the boss, which need only be two or three threads deep, as it only has to stand the few pounds of exhaust pressure, and file off flush. Run the 5/16in. by 40 tap in the side hole again, to remove any burring. Nothing very difficult about that, is there ? Drill the five No. 21 screwholes in the flanges, and the-worst is over!

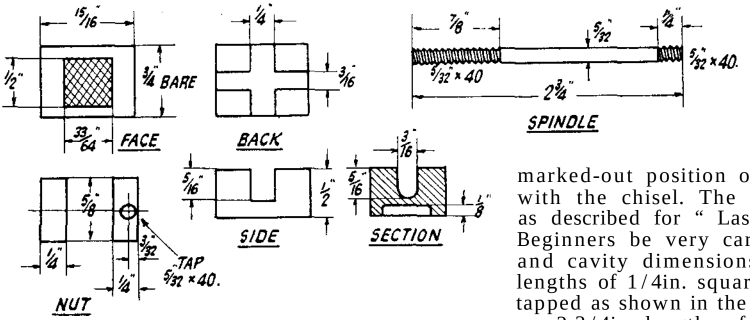
Covers and Piston

The front cover is merely a plain disc with a 1/32-in. register projecting from one side, to fit in the bore, and has eight No 34 holes drilled around it, same as the back cover shown, from which measurements can be taken. The back cover needs a little more care. Briefly, chuck by spigot provided, and turn the register to an exact fit in the cylinder bore, facing it off, also the flange, at the same setting. Then centre and drill 7/32-in. for a depth of about 1/2 in. Saw off the chucking spigot, and re-chuck, boss outwards, either gripping by the edge in the three-jaw, or else holding the edge in a stepped ring, as described for previous engines in this series. Face off the gland boss, open out to 5/16in. depth with 11/32-in. drill (pin-drill if you have one, to ensure piston-rod being dead central) and tap 3/8in. by 32 or 40. Make a gland to suit, from 1/2in. bronze rod, and ream it 7/32 in. Put four C-spanner nicks in the flange, with a fine flat file or hacksaw. The outside of the boss can be carefully filed to the given shape and size. After drilling the screwholes (and don't forget the two nearest the steam chest should be clear of the passage-ways) put the cover in place, stand the casting with the port-face down, on the lathe bed. Put a try-square beside it, and adjust the cover so that the blade of the square lies against the flat part of the boss ; doesn't matter which end. Run a No. 34 drill in one of the screw-holes, making a countersink on the flange ; follow with No. 44, tap 6-B.A., and put a screw in. This will hold the cover whilst you make the countersinks for all the rest.



Exhaust passages

Cut two pieces of 7/32-in. rustless steel or bronze rod, each 3-3/16 in. long, and put 1/4 in. of 7/32-in. by 40 thread on one end, by aid of a die in tailstock holder. Drawn bronze rod is best for pistons, or castings of different grade of alloy. Dural can also be used, or rustless steel. Rough out to about 1/64in. over size ; then chuck each blank truly in three-jaw. Centre, drill through 3/16 in., open out to 1/4 in. depth with No. 3 drill, and tap the rest of the hole 7/32-in. by 40. Put a piston-rod in tail-stock chuck, run up to piston, enter the screwed part, and pull belt by hand until piston rod is right home. For beginners' benefit, may I repeat that this “ precision chuck ” way of fitting pistons to rods, is the best I know of, from actual experience. They run dead true and never come adrift. Now chuck each piston-rod in a split bush in the three-jaw, as described for “ Lassie” pistons, and turn until the piston just slides into the cylinder bore without vestige of shake.



Slide-valve, nut and spindle

Steam-chests

The rest is plain sailing. The steam-chests can be held in the four-jaw for facing both sides in turn, using a round-nose tool set cross-wise in the rest. The casting can then be rechucked endwise, with the gland boss outwards, in the four-jaw, and the boss set to run truly. Turn the outside of the boss ; face, centre, drill right through with No. 21 drill, open out to 1/2in. depth with 9/32-in. drill, and tap 5/16in. by 32 or 40. Make the gland from 3/8in. hexagon bronze rod, and ream it 5/32in. Screw-holes are drilled as shown. The cover is simply a piece of 1/8in. brass, 2-1/8in. long and 1-1/4in. wide ; clamp it to the steam-chest with a toolmaker's cramp, and poke the drill through the lot. The steam-chest can then be placed in position against the port-face, held with a cramp, and the screw-holes located, drilled, and tapped, same as the end covers.

Slide-valves and Spindles

Each slide-valve is made from a block of bronze (bit of drawn bar is best) or a casting. If the latter, the cavity and ***grooves will*** probably be cast in ; if not, the cavity can be chipped out with the chisel mentioned for cutting ports. Drill a few countersinks 1/8 in. deep all over the marked-out position of the cavity, and finish with the chisel. The grooves can be milled, as described for “ Lassie,” or sawn and filed. Beginners be very careful to keep to overall and cavity dimensions. The nuts are 5/8in. lengths of 1/4in. square brass rod, drilled and tapped as shown in the illustration ; the spindles are 2-3/4in. lengths of rustless steel or bronze rod, one end screwed for 1/4in. length, and the other for 7/8in. length. The whole cylinder is assembled as shown in the sectional and end views.

Pistons and glands are packed with graphited yarn, as described for previous engines, and cover joints can be made with oiled brown-paper gaskets, cut out with the domestic scissors. There is no need to attach the steam-chests to the cylinders “ for keeps ” yet, as they have to come off for erection.

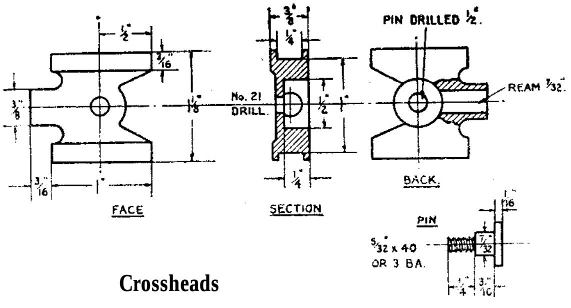
" Juliet " ——— By "L.B.S.C."

Guide-bars and crossheads

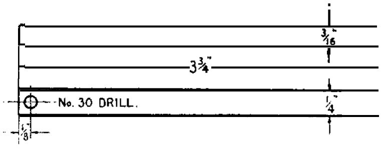
THE guide-bars are merely four 3-3/4in. lengths of 3/16in. by 1/4in. steel (silver-steel is best, but mild will do) squared off at both ends, and a No. 30 hole drilled through each at 1/8in. from one end. They are attached to the flat places at top and bottom of the piston-gland bosses, by a single 1/8in. or 5-B.A. screw in each.

The crossheads are also simple, of a type first suggested by an old friend, Mr. F. A. Tye, now of Watford, many years ago, in which a crosshead-pin with a large flat head is fitted into a pin-drilled recess, giving all the strength of a double-sided crosshead of the usual pattern, but far less trouble to make up. Castings may be supplied for the pair, or they may be made up from 1-1/8in. by 3/8in. bar material ; steel, bronze, or hard brass will do. Chuck a piece a little over 2-1/2 in. long in the four-jaw; set to run truly and turn down 3/16 in length to 3/8 in. diameter. Face, centre and drill No. 4 for about 1/2 in. depth. Reverse in chuck, and repeat operations. Cut a groove in each narrow side 1/4 in. wide and 1/16 in. deep,; try a guide-bar in the groove, and see that it slides easily. These grooves can be milled in the lathe by clamping the piece under the slide-rest-tool-holder, at right-angles to the bed, and level with the lathe centres and traversing across a 1/4in. home-made slot-drill held in the three-jaw. I have described how to make these slot-drills several times. Briefly, file the end of a piece of 1/4in. silver-steel like a screwdriver, make a 1/16in. nick in the middle, back off the edges each side of the nick, and harden and temper to dark yellow. I find that they cut faster and cleaner than the usual multi-edged commercial endmill.

At 11/16 in. from each end of the piece, on the centre-line, make a centre-pop and drill right through with a No. 21 drill ; be certain the drill goes through square with the sides. Then open out to 1/4 in. depth with a 1/2in. pin-drill, another gadget you can make for yourselves in a few minutes. Saw the piece in half, file the ends as shown in the illustrations, and, if you so desire, recess the outside 1/32 in., as shown, for sake of appearance. but this makes no difference to the working. The crosshead pins are turned from 1/2in. round mild-steel, to the dimensions given on the detail sketch. The head should fit the pin-drill recess exactly, and lie flush with the side of the crosshead. Ream the bosses with a 7/32-in. parallel reamer, so that they will fit tightly on the piston-rods.



Crossheads



Guide-bars

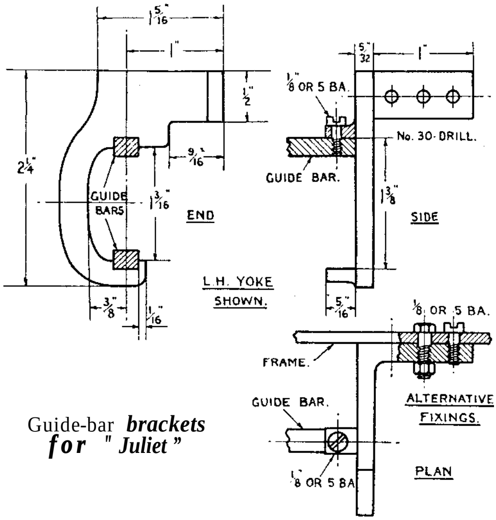
Guide-yokes or Motion-brackets

Castings will be available for these, and all they need is a little attention with a file. Clean up the side of the lug that fits against the engine frsme, and file the two nicks for the guide-bars. Drill three No. 30 holes in the lug for attachment to frame, and one each in top and bottom guide-bar supports.If the casting is at all rough, smooth it off for sake of appearance.

The yokes can be built up if desired, using a piece of 1/8in. steel, same as used for frames, measuring 1-3/4 in. by 2-1/4 in. File to the shape shown. The lug for attaching to frames can be made either from a piece of r-in. by 1/8in. angle, 1/2 in. long, riveted to the main part of the yoke, or a piece of 1/2in. by +-in. flat bar, I in. long, brazed or silver-soldered at right-angles to the yoke. The supports for the guide-bars can either be small pieces of angle riveted to the yoke, or little pieces of flat bar, say, 1/8 in. by 1/4 in., brazed or silver-soldered to it, end on, above and below the nicks for the bars. Don't forget that these nicks must be made so that the bars are dead parallel for their full length. That is where the fitter's skill comes in! Judging from correspondence, many beginners think the bits of a locomotive should fit together like a jig-saw puzzle, or a set of radio components, and don't seem to realise that judicious use of both tools and noddle is called for !

Connecting-rods

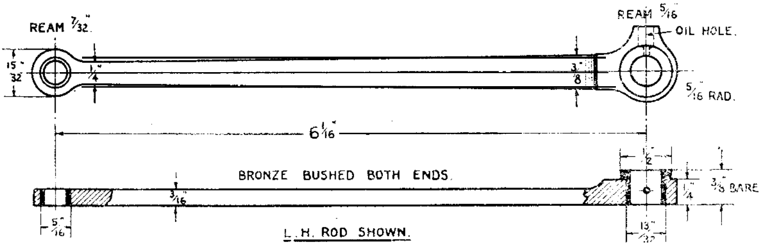
These are made from two 6-3/4in. lengths of 1/4in. by 3/4in. mild-steel bar, by the same process as is used for coupling-rods. The big-end is drilled 13/32 in. and has a flanged bronze bush pressed into it, the total width being 3/8 in. bare. The little-end is drilled 5/16 in. and has a flush bronze bush pressed in. Tip-when making the bushes, drill slightly undersize, and poke the reamers through after the bushes have been squeezed home, using the vice as a persuader. Both bushes should be exact fits on their pins, running freely without shake. The little-end boss should easily fit the recess in the crosshead ; and when the crosshead-pin is put in, and nutted-up tightly on the outside, the little-end should be free to move up and down around the pin, but with only the weeniest bit of side movement. Don't forget to drill a 1/16in. oil hole in the big-end boss.



Guide-bar *brackets* *for "Juliet"*

How to Erect

Take off the steam-chests and put the cylinder port blocks through the frames, holding in position with a toolmaker's cramp whilst you drill the frames with No. 21 drill, using the holes in the cylinder-flanges as guides. Couple up the connecting-rods to crossheads, and put the latter between the guide-bars, pushing the crosshead-bosses temporarily over the ends of the piston-rods ; then put the cylinders in place on the frame, with the connecting-rod big-ends on the crank-pins, and fix the cylinders with 5/32-in. screws or bolts, with nuts inside the frame. Turn the wheels so that one crosshead is at the outer end of the guide-bars ; then put on the guide-yoke, level with the end of the bars, and the small lugs lining up with the bars. Hold in position with a cramp, whilst you drill the holes in the frame, using those in the main lug as guides for the drill. The yokes are attached to the frame either by 1/8in. bolts or nutted screws, or screws without nuts. In the latter case, drill the holes in the lug No. 40 instead of No. 30, and after temporarily clamping in position put the No. 40 drill through frames as well. Remove yoke, tap the holes 1/8 in. or 5 B.A., open out the holes in the frames with No. 30 drill, and fix with cheese- or hexagon-head screws put through from the inside.



Connecting-rod

Line up the guide-bars with the small lugs, and put a small cramp on, or else keep the crosshead at the end, which will hold them in place. Put a No. 30 drill down each hole, make a countersink on the bar, and follow up with a No. 40 drill, but shift the crosshead before it breaks through, or the groove will be damaged. Tap the hole 1/8 in. or 5 B.A., put in a screw, and file off any of it that projects between the bars, so that the crosshead is free to pass the screws.

Push each piston-rod into the cylinder as far as it will go, the pistons touching the front covers. Put one of the cranks on front dead centre, so that the crosshead-boss goes over the piston-rod, then advance the piston-rod into the crosshead by another 1/32 in., which will give that amount of clearance between the piston and cover. Drill a No. 43 hole right through crosshead boss and piston-rod, and squeeze in a pin made from 3/32-in. round silver-steel. The big-end is stopped from coming off the crankpin by an ordinary commercial nut and washer.

How to Set the Valves

Put the steam chests in position, fixing by two temporary screws, and leaving the covers off. Couple up the eccentric-rods to the valve crossheads or forks. Tighten the stop-collar set-screws in any position on the axle, turn the wheels by hand, and watch the valves. If both ports don't open the same amount, adjust the valve nuts until they do, by pulling out the pin in the valve crosshead and turning the valve spindle, which advances the nut, or retards it, whichever way the valve wants to go. When you have equal port openings at each end of the valve movement, loosen the stop-collar set-screws, and set one of the cranks on front dead centre. Turn the corresponding stop-collar in a forward direction until you can just see the edge of the front port showing as a black line at the lap of the valve ; then tighten the set-screw. Now turn the wheels a complete revolution backward, until the crank is on front dead centre again. The other shoulder of the stop-collar should have caught the pin in the eccentric, and the port should just be " cracking " again. If no port is showing, and the wheels have to be turned further around before the black line appears, the shoulder is too far back, and must be packed out, which can easily be done by soldering or screwing a little piece of sheet brass, or a block, to the shoulder. If the port is opened more than a crack when the crank arrives at dead centre, the shoulder is too far forward ; chip a little bit off it with a small chisel. When the ports crack at each end, on dead centres, in both directions, the valves are correctly set, and the steam-chest covers can be put on. Next items, steam and exhaust pipes, and lubricator.

“ Hielan’ Lassie ”

The Final Brazing Job

Whilst the brazing operation on the foundation ring, backhead flange; and bushes is the last, it certainly isn’t the least, but all those good folk who are not scared of a five-pint or larger blowlamp going full blast have nothing whatever to- fear. -I’ve done many similar jobs before going over to oxy-acetylene equipment and got so hot that the buttons on my overall coat became too hot to touch, and a fountain pen inadvertently left in the top pocket assumed the shape of a sausage (I’d better not say banana !) ; but that was because it was done indoors-not in my workshop, but the domestic scullery-on a rainy day. If you can possibly do the job outdoors, or in an outhouse, garden shed, or even an ex-air-raid-shelter, it is much to be preferred. The “ fumes ” will rust up every bit of bright steel with which they come in contact ; and they aren’t exactly good to inhale, either. At the same time, if you don’t get your face too close to the job, there isn’t the slightest risk of being gassed !

Put a bit of fresh coke in the brazing pan, also get the tin tray or pan with the hole in it which was used for the smokebox tubeplate. If the hole is a tight fit on the barrel, make it dead easy with about 1/8in. clearance (“ five-eight-fitter’s ” fit. that !) and prop it up on a couple of bricks, or other support, which may be handy and convenient, so that, if the boiler barrel is poked downwards through the hole, the backhead is at a convenient height from the ground, to operate on. Then anoint all the joints with wet flux ; if using Boron compo for ‘your spelter work, put some all around the foundation ring and backhead flange. Use either borax-and-water for silver-solder, or “ Tenacity No. 3 ” for Easyflo, for the firehole ring flange and all the bushes. Have all your tools and brazing material handy, so that you don’t have to stop and look for anything, and risk the job cooling off. Also have some extra coke handy, and a small shovel or scoop for use with same.

Lay the boiler lengthwise in the pan, on its back with the barrel to your left, and pile some coke around it, to the level of the foundation ring. Put some bits of asbestos (cubes. broken gas-fire elements, or anything similar)* in the firebox almost to the level of the ring, and put a piece of sheet asbestos over them to protect the inside joints of the firebox and combustion chamber. If YOU have a small blowlamp as well as the big bov. get that going as well ; every little helps. Make certain they won’t die out on you for want of oil whilst the job is in progress ; then you are all set for the great adventure.

The “ technique ” of this job is similar to that of the previous job, but this time you really do need plenty of heat. as the whole boiler must be well hot. I’ve often said in jest that, when you can see the tubes through the boiler barrel, it’s just hot enough ; but, joking apart, you won’t stand any risk of burning an assembled boiler the size of the “ Lassie’s ” with a five-pint lamp or its equivalent in ordinary air-gas blowpipes. Even with the oxy-acct., it would be a difficult matter ; all being well, when I shortly arrive at the boiler stage of the 3-1/2in. gauge “Bantam Cock ” which I am now building “ in parallel ” with old “Grosvenor,” I shall use the biggest tip in my “ Alda ” set, the 1,000-litre. As before, heat up the boiler at the firebox end. until all the piled-up coke glows red ; you can put the smaller lamp, if available, on the opposite side, to help keep the coke glowing. Then concentrate on the corner of the foundation ring nearest you. When this reaches medium red, dip the stick of spelter in the dry flux and apply it to the copper. If it doesn’t melt and run after a second or two, the copper isn’t hot enough ; give it some more “ heat treatment.” If the stick doesn’t start to melt at bright red, it is a bit shy of starting ; a touch of coarse-grade silver-solder applied directly before the spelter will teach it manners.

Once the metal starts to flow. it will keen flowing, so advance the flame a little along the ring, in the direction in which the flame is blowing-and feed in a little more spelter, continuing the same way until you reach the throatplate joint. If you have bent out the firebox plate to meet the throatplate, as shown in the longitudinal section, this part of the job will be equal to the airman’s famous “ piece of cake,” as there isn’t such a lot of metal to keep hot, and the spelter will flow freely into the joint between inner and outer plates. If you have left the inner plate straight, and put a piece of square copper rod in, as given for the alternative, you’ll have to “wait for it,” same as when doing the side seam.

The continuation of the job from the farther side of the throatplate is a matter of choice. A “ tack-handed ” boilersmith will probably prefer to take the blowlamp in his left hand and work backwards towards the backhead. An ordinary right-handed individual would, I fancy, do best to come back to the starting point, heatupagain, first go along the piece of ring between backhead and firebox, and turn the corner and proceed ahead alone: the other side of the firebox. Although I can use both hands equally well on most jobs, I usually adopted the latter course in “ blowlamp days.” Anyway, watch one point, whichever way you go. When the circuit is complete, take mighty good care to heat up the last bit, so that there is a perfect joint between the starting and finishing points. Beginners and inexperienced workers are apt to forget, when they arrive at the “winning post,” that the “ starting gate ” has been out of range of the blowlamp for some little time, and has cooled off sufficiently to prevent the spelter amalgamating properly with it. Unless the flame is played on the cooled-off part for a time sufficiently long to bring it to the original temperature, the molten spelter will just stick to the surface, and you’ll have a fine Welsh vegetable growing there when the boiler is steamed up. It may seem sound on the cold water test ; but wait until the expansion and contraction stresses, under working conditions, get busy! Another point is that plenty of flux is needed at the point mentioned, as there may be a little oxidation resulting from the first heating, if the job hadn't sufficient flux applied to it in the first place.

Quick Work Needed Here !

Grab the boiler with the big tongs, lift it clear of the long pan, and pop it, barrel downwards, through the hole in the auxiliary pan, shovelling some coke around as quickly as you can, piling up same to the level of the backhead. Then get the coke glowing ;and when it is well red, start at the bottom of the backhead, and work your way all around, exactly as described for previous seams. Don't hurry ;see that the spelter runs well into the joint between backhead and wrapper before you move the flame along for the next inch. Take the same precaution when arriving at the terminal point.

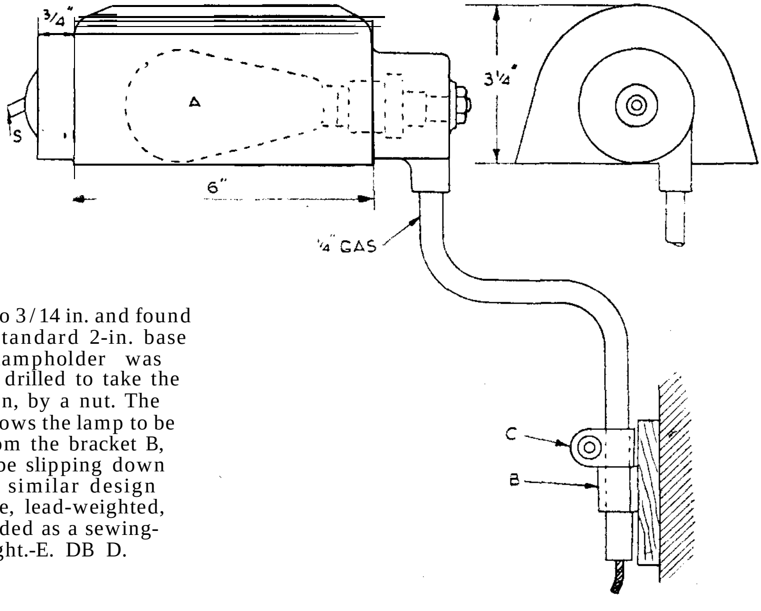
Next, play the flame straight on to the firehole ring ; and when this and the surrounding metal reddens, dip your stick or strip of silver-solder into the flux and apply it to the flange. Silver-solder, especially " Easyflo," being very fluid, it will run around and " sweat" in. Give the regulator bush a dose of the same medicine. Then make another snatch-and-grab raid and this timedeposit the boiler in the long pan rightway up. There will be no need to pack any coke around this time, for if the blowlamp flame is directed straight on the bushes in turn (dome ring and safety valves) it will provide enough local heat to melt the silver-solder when applied. Finally, let cool to black, and deposit the boiler in the pickle. As the acid enters the interior of the boiler first time and touches the hot "innards," it usually blows out again in double-quick time, so take all precautions against splashing. By the time of " second entry,"the shell and tubes have cooled sufficiently to allow the acid pickle to stay in. Leave the whole issue in the pickle for 20 minutes or so, then fish it out with the big tongs, and well drain it before proceeding to the kitchen sink for washing inside and out. If any pickle spots are dropped on floor, mats, or lino, it will do them a bit of no good, and you don't want to upset the good lady and give her any valid excuse for "going for you," if only verbally. For my own part, I have a tap outside the "Crystal Palace," as we call our glass lean-to, and a short length of hose attached, so all I have to do is lay the boiler in the gully, and do a bit of N.F.S. practice on it.

The boiler can then be given a rough test, to ascertain if there are any pinholes in the brazed joints, in much the same way as you test a car or cycle tyre for punctures. Turn up an adaptor to screw into one of the safety-valve bushes, from any odd bit of brass, and solder a tyre valve--or the screwed part thereof-into it. Plug the rest of the holes ;bits of wood screwed into the tapped bushes, making their own thread, does O.K., and a big cork in the dome hole will do the trick if you tie a bit of string around the barrel and over the cork, so that it doesn't blow out. Couple a tyre pump to the adaptor, and put the boiler in the family bath, or anything else that might be available, with enough water to cover it. Pump some air in the boiler, about 20 lb. or so, and if there are any faulty places in any of the joints, a string of bubbles will mark the spot. There is no need to reheat the whole bag of tricks to stop a pinhole ; just drill it No. 55, tap 10 B.A. and screw in a stub of threaded copper wire with a smear of plumber's jointing on the threads. Screw about 3/16 in. of the wire, and turn it until it breaks off in the hole.

A Light for the Lathe

THE lathe light shown in sketch was made mostly from scrap and has proved most useful, especially in avoiding eye-strain.

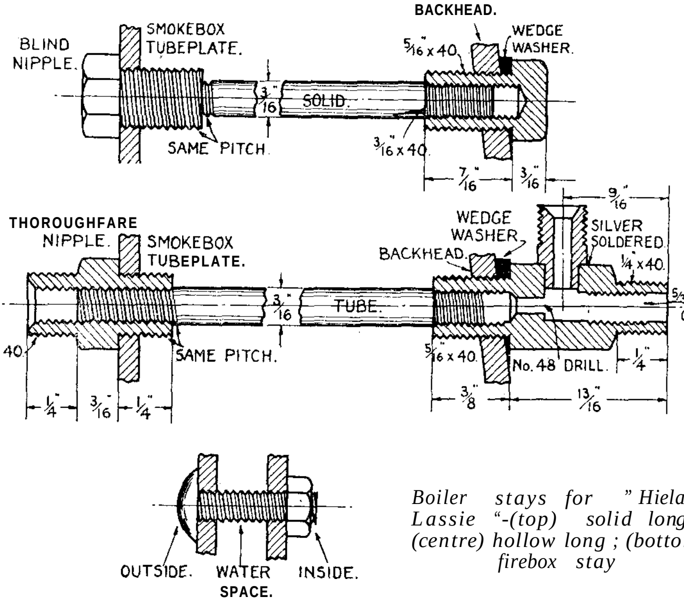
The lamp body is an aluminium casting used in pre-war days for sign-lighting and now obtainable from most surplus-store dealers. The left-hand ring extension was cut down to 3/14 in. and found to house just nicely a standard 2-in. base tumbler switch. The lampholder was soldered to a 3/8in. rod drilled to take the cable and fixed, as shown, by a nut. The swan-neck 1/4in. pipe allows the lamp to be swung over the lathe from the bracket B, clip C preventing the tube slipping down through the bracket. A similar design with substantial oak case, lead-weighted, has been highly commended as a sewing-machine and reading light.-E. DB D.



Stays for “ Hielan’ Lassie

By “L.B.S.C.”

FOUR longitudinal stays are required, three being solid rods, and the fourth a piece of heavy-gauge tube which carries steam for the blower. The three solid rods are 21-1/2in. lengths of 3/16in. round copper, screwed about 1/2 in. each end.If your lathe has a hollow mandrel, hold the rods in the three-jaw and use a 3/16in. by 40 die in the tailstock holder ; if not, screw by hand with the rod held in the bench vice, but get the threads as true as possible. If the thread is wobbly, *or* “ drunken,” as the shopmen call it, the end of the stay will be strained when screwing on the blind nipples, and its staying power seriously reduced. Don’t forget a drop of cutting-oil ensures clean threads. The blind nipples are shown in the accompanying detail sketch, included for novices’ benefit. Chuck a bit of 3/8in. hexagon brass rod in three-jaw; face, centre, drill down with No. 22 or 5/32in, drill for about 1/2in. depth, and tap 3/16in. by 40. Turn down 7/16 in. of the outside to 5/16in. diameter, screw 5/16 in. by 40, and part off to leave a head about 3/16 in. in thickness. Reverse, and chamfer the corners of the hexagon.



Boiler stays for ” Hielan Lassie “-(top) solid long ; (centre) hollow long ; (bottom) firebox stay

Set out four points on the backhead, corresponding to the four shown on the drawing of the smokebox tubeplate ; but instead of drilling them at right-angles to the tubeplate as usual, they have to be drilled parallel with the boiler barrel. As I have a pillar drill, naturally I find this quite easy, as all I have to do is to up-end the boiler on the driller table, standing it on the smokebox end, and poke the drill straight through the centre pops, which are made very heavy. When tapping, I put the tap in the drill chuck, and turn the drill spindle by hand ; a spot or two of cutting-oil on the tap, and there we are, all present-and-correct-sergeant. If you haven’t a drilling machine at all, or one that is too small to admit the boiler between chuck and table, the only thing to be done is to drill and tap by hand, taking care to keep the drill brace parallel with the boiler barrel when drilling, and using a tap with a long taper to start the thread in the hole. It will be found an advantge to drill a pilot-hole first with a No. 30 or 1/8in. drill, and follow up with the tapping size, viz. 9/32 in. Tap 5/16 in. by 40.

A wedge-shaped washer will be needed under each nipple-head at the backhead end, as shown in the illustration ; these are simply slices parted off a drilled 3/8in. brass rod held in three-jaw and filed to the necessary taper. To insert the stays, screw one of the nipples on to one end for about three threads, and put a wedge washer over the thread on the nipple. Put a piece of thin 1/4in. tube on the other end, which should be a tight push fit ; the exact length doesn’t matter. Insert the tube through the hole in the backhead, and push the stay through after it, until you feel the tube come up against the smokebox tubeplate. A little judicious juggling will then be called for, to get the end of the tube through the corresponding hole in the smokebox tubeplate; but, once through, screw the nipple at the backhead end right home, adjusting the washer to allow perfect contact between it, the nipple head, and the backhead. The tube can then be pulled off the stay at the smokebox end, leaving three or four threads of the stay projecting through the hole. Screw on another nipple, and this will also engage with the tapped hole, so that when the nipple is right home, the whole issue is locked solid. A smear of plumbers' jointing on the threads will ensure steam-tightness.

The hollow stay is 1/4 in. longer than the solid ones, and is made from 3/16in. by 16- or 18-gauge copper tube. Screw both ends 3/16 in. by 40 as above, but put about 3/4 in. length of it on one end, and 1/4 in. on the other. The blower valve is attached to this end. To make it, chuck a bit of 3/8in. hexagon brass rod in three jaw ; face the end. centre. drill down a full 1/4 in. with 5/32in. or 22 drill, and tap 3/16in. by 40. Turn down 3/8in. of the outside to 5/16in. diameter, screw 5/16in. by 40, and part off 13/16in. from the shoulder. Reverse in chuck ; turn down 1/4 in. of the outside to 1/4in. diameter, and screw 1/4 in. by 40. Centre, drill right through with No. 48 or 5/64in. drill ; open out to about 1/2 in. depth with No. 30 drill, and bottom the hole to 5/8 in. depth with a D-bit. Open out further with No. 21 or 5/32in. drill, for about 1/8 in. depth, and tap the rest of the No. 30 hole with a 5/32in. by 32 tap it you have one ; if not, use 40, but a coarser thread gives quicker action to the valve, which is an advantage on the road. Drill a 3/16in. hole at 1/4 in. from the shoulder, in one of the hexagon facets ; and in this fit and silver-solder a 1/4in. by 40 nipple, as shown. Chuck a bit of 1/4in. ***round*** brass rod in three-jaw ; face the end, centre deeply using size " E " centre-drill, and drill down about 3/8 in. with No. 40 drill. Screw the end for about 1/4 in. length with 1/4in. by 40 die in tailstock holder ; part off a full 5/16 in. from the end, reverse in chuck, and turn 1/16 in. of the plain end to a tight squeeze fit in the hole in the side of the blower valve.

The nipple on the smokebox end of the stay is a " thoroughfare " one. Chuck a piece of 3/8in. hexagon brass rod in the three-jaw ; face, centre, deeply with a size " B " centre drill, turn down 1/4 in. of the outside to 5/16in. diameter, and screw 5/16 in. by 40. Part off at 11/16 in. from the end; reverse in chuck, and ditto repeato the turning and ***screwing*** process. Drill right through with No. 22 or 5/32in. drill, and tap 3/16 in. by 40.

Screw the hollow stay into the end of the blower valve, not forgetting a taste of jointing paste, and put on a wedge washer. Put a bit of wire down the tube, or use the extension, same as with the rod stays ; then insert in the extreme right-hand hole in backhead. Wangle the extension tube or wire through the corresponding hole in the smokebox tubeplate, pull it away, screw the blower valve right home, so that the nipple on it points skywards, and put on the thoroughfare nipple. You need not wrench them up tight enough to strip the threads (beginners usually do !), as the usual brands of plumbers' jointing, such as Boss White, make a perfectly steam-tight seal with quite moderate tightness.

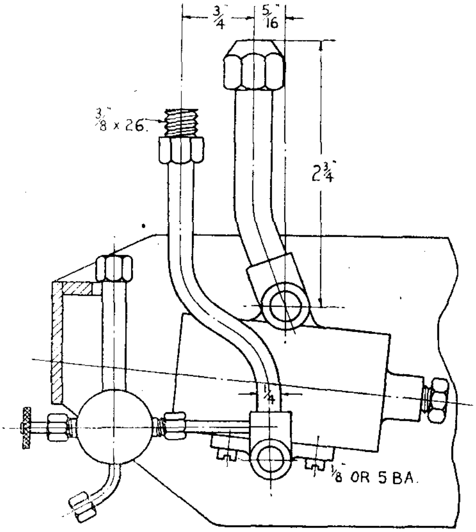
Firebox Stays

The job of staying a firebox is, in your humble servant's estimation, the most monotonous part of the whole doings, though some of my old munition girls would have Ioved it. They work differently from boys. With a cup of tea alongside the machine, they would have drilled and tapped all the holes, made the staybolts, screwed them home and nutted them, quite automatically, whilst their minds were far away with boy friends. dances, pictures, or pretty frocks. I go to work in exactly the same way, doing the job automatically whilst I daydream about childhood, with sweet oranges at six a penny, 'dates at twopence a pound, and boiled sweets at a halfpenny more; or else my spirit takes a run on ***Wigmore*** or P***urley***, with an evening suburban train, first stop Norwood Junctionin 13 mins. from London Bridge, or maybe works the Thursday afternoon " Early Closing " excursion to Brighton with old ***Fairlight,*** hauling sixteen four-wheeled " cattle-box " thirds, with straphangers in every compartment and ail the springs out straight, sailing into the terminal in verv nearlv "even time" by aid of one solitary pair of driving wheels plus a little sand and " common savvy." Happy days !

Getting back to present realities, there are 21 stays in each side of the firebox, 7 in the throatplate and 8 in the backhead. The position of all the holes is shown on the longitudinal and cross sections of the boiler already published. Drill them with No. 30 drill, clean through both outer and inner plates, and tap either with a tap having a very long taper or a pilot pin. You can make either at home, from a bit of 5/32in. silver-steel either turning a long taper, or a pilot pin which will just enter the No. 30 holes, long enough to project just through the firebox plate before the thread starts to cut. Screw sufficient of the steel at the end of the pilot pm or taper to span both plates say 5/8 in, if unable to flute the screwed portion. file four 'flats on it. Harden and temper to dark-yellow, and use with plenty of cutting-oil. A squared tap won't cut such a perfect thread as a fluted one, so if you square yours, run an ordinary second tap through the holes afterwards.

The staybolts are made from soft copper rod. The finest stuff I have ever used-and am still using-is obtained by unravelling the strands of scrap ends of high-tension electric cable (Milly Amp isn't shy of helping her steam friends !) This wire is high-grade copper, ductile, and takes a lovely thread. If ordinary commercial copper rod is used, soften it ; cut up into about 4-in. lengths, make them red-hot, drop into ***your*** pickle bath, and well wash in running water. This cleans them as well as softens them. Screw each end of each piece for about 5/8 in. length with a die in tailstock holder. There are no commercial brass lock-nuts tapped 5/32 in. by 40, so these will have to be home-made. Chuck a bit of 1/4in. hexagon brass rod in three-jaw ; face, centre, and drill down for 5/8 in. or so with No. 30 drill. Tap 5/32in. by 40, and part off three 1/8in. slices. Ditto repeato until you have about half a gross ; a few spares will come in mighty handy. They should be chamfered both sides. Chuck a bit of 1/4in. round rod in the three-jaw ;turn down 1/8 in. of the end to 5/32in. diameter, and screw it 5/32 in. by 40. Screw each nut on this, and touch the comers of the hexagon with a square-ended tool ground off obliquely at one corner. Sounds a long job to do the lot, but you can do it automatically whilst thinking about filling up your football pool coupon or doing a crossword puzzle !

Screw a tap-wrench in the middle of the stay rod, between the two portions of thread, and this will enable you to screw the threaded end of the rod through both plates until it beds tightly into the tapped hole in the outer plate of the boiler. Snip off the rod about 3/32 in. from the plate, put a nut on the inside, and tighten it with one of the box-spanner gadgets which I described a short while ago. The bit of rod can be re-screwed for two more stays. When you have got all the lot in-and it won't take as long as you anticipate -put a bar of iron in the bench vice, projecting sideways from the jaws. Rest the inner end of each stay on it whilst you head over the outer end with the ball end of the hammer head. When through, give all the nuts a final nip up, and the job is complete.



" *Juliet* " pipes and *lubricator*

How to Sweat Up Heads and Nuts

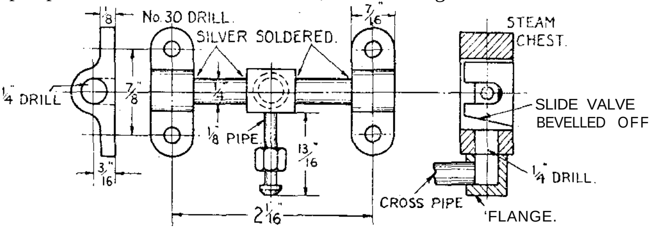
By the good rights, if the stays are screwed without torn threads, and the tap doesn't " cut large," the stays should fit steam-and-water-tight in the copper plates, and require no further treatment. However, to make assurance doubly sure, it is always advisable to sweat over all the heads and nuts with solder. Plumbers' solder is the best, as it has a higher melting point than ordinary tinman's solder, although the latter will do quite well if the former is not available. For this job your small blowlamp will come in handy ; you also need a copper bit (soldering-iron), some liquid flux, and a small wire brush. Once more a warning: don't on any account use a paste soldering flux for boiler work. Paste fluxes may be all right for certain jobs, such as mending pots and kettles, and electrical connections ; but I have yet to find *one* that is satisfactory for our purposes. Once any trace of it gets inside the boiler, you'll never get rid of it, and the gauge glass will emulate Ananias "for ever and aye." Also, a liquid flux will wash off any dirt or oxide that paste flux won't look at. Any of the good proprietary fluxes, such as Baker's fluid, will do, or you can make your own by dissolving zinc in muriatic acid (spirits of salts) until it won't take any more, and then adding a little sal ammoniac. Lump chloride of zinc, dissolved in water, is also O.K. Manufacturing chemists sell it. The wire brush can be home-made by tying a bundle of fine iron wires on the end of a stick.

Lay the boiler *on* its side in the brazing pan, and brush some flux *over* all the stay-heads and nuts on the " up " side. Heat the boiler to the melting point of the solder, with the blowlamp, and touch the stayheads and nuts with the solder stick, or melt off a little between the heads and nuts. Then, keeping up the heat, dip the wire brush in the flux and apply it to each head and nut, which will cause the melted blob of solder to run all around it. Alternatively, melt up a little pool of solder between the heads and nuts, and brush it over all the lot. This is especially suited for doing the nuts inside the box, as the melted solder can be brushed completely over the surface, covering rivet heads and joints as well, so that if a beginner has a doubtful spot in his brazing or riveting, the solder will seal it. Keep dipping the brush in the flux all the time. If the solder refuses to run around one particular stay, apply the hot soldering-bit in the blowlamp flame, and some extra flux and solder. That will teach it manners! When every head and nut is covered, inside and out, let the boiler cool until the solder sets, then give it an extra good wash, inside and out, to remove all traces of flux. Next stage, testing.

"Juliet"

Steam and Exhaust Pipes

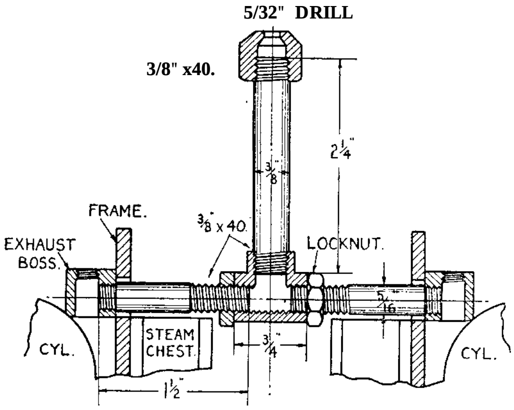
Whether a mechanical or displacement lubricator is used, the arrangement of steam and exhaust connections is as shown in the accompanying illustration. For displacement oiling, the underneath connection to the steam chests is necessary, as oil won't run uphill of its own accord, which rules out a top connection; and the accessibility is useful if a beginner ever wants to dismantle the cylinders without removing the boiler, which, with the arrangement shown, is easily done. For mechanical lubrication, a clack or check-valve is added to the tee on the cross. pipe below the steam chests.



Steam pipe and flanges

The exhaust pipes should be put in first. Castings will be available for the tee piece; chuck by one end, set the other to run truly, face, centre, drill right through with 9/32in. drill, and tap 5/16 in. by 40. Screw the faced end on to a stub of rod in the chuck, turned down and screwed to suit, and face off the other end. Chuck in four-jaw, with stem outwards and set to run truly; face, centre, drill with an 11/32in. drill into the cross passage, and tap 3/8 in. by 40. Run the 5/16in. tap through the cross hole again to remove any burrs. Make two 5/16in. by 40 lock-nuts, as described above for "Lassie's " stay nuts.

Cut two pieces of 5/16in. copper tube to a length of 1-1/2 in. ;screw one end for 3/16 in. length and the other for 5/8in. length, 5/16 in. by 40. Put a lock-nut on each longer end, and screw them into the tee until they touch in the middle ; hold the tee midway between the cylinders, opposite the exhaust holes, then screw the pipes out of the tee, into the holes in cylinders, finally tightening up the lock-nuts against the tee. Note, the stem of the tee is inclined slightly forward, as shown in the side view.



Exhaust pipes

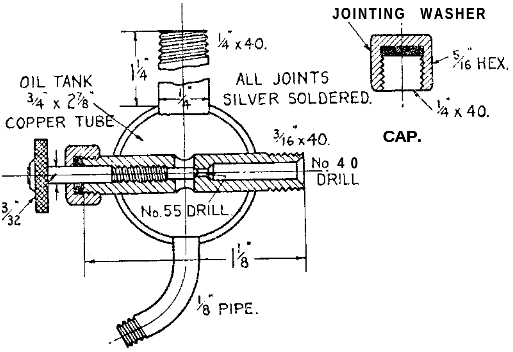
The blastpipe is a 2-1/4in. length of 3/8in. copper tube, screwed at both ends 3/8 in. by 40, and bent slightly, as shown, so that its centre-line is 5/16 in. ahead of the centre of the cross pipe. To make the nozzle, chuck a piece of 7/16in. hexagon or round brass rod ; face, centre, and drill about 5/8 in. deep with a 5/32in. drill. Open out to 7/16 in. depth with 11/32in. drill, tap 3/8 in. by 40, and part off a full 1/2 in. from the end. Reverse in chuck, and turn the top slightly coned, as shown. Screw it on the blastpipe to full depth of thread. No jointing material is needed on exhaust pipes.

Assembly

The steam pipe assembly is simplicity itself, as no screwed joints are needed in the pipes at all. The two flanges for attachment to the steam chests can either be castings or filed up from 1/2in. square brass rod. The cross hole in the tee is drilled 1/4 in., and the stem same size. The 1/4in. cross pipes are fitted tightly into both tee and flanges, and a 3-in. length of 1/4in. pipe, bent as shown in the side view, is fitted into the stem of the tee. A union-screw is fitted to the top of the cross pipe ;to make it, chuck a piece of 7/16in. hexagon rod in three-jaw. Face, centre deeply drill down 5/8 in. depth with 7/32in. drill, turn down 1/4 in. of the outside to 3/8in. diameter, screw 3/8 in. by 26, part off 1/2 in. from the end, reverse in chuck, and open out 1/8 in. of the other end with a 1/4in. drill. Press it on as shown. Drill a 1/8in. hole in the tee, and fit in it a 7/8in. length of 1/8in. pipe with a union-nut and cone on the end. The whole of the joints-side flanges, tee, and steam union-can then be silver-soldered at the one heat. Pickle, wash off, and clean up.

Clean Passages

Drill a 1/4in. hole in the bottom of each steam-chest, right in the centre, between the two middle fixing-screws. You'll have to take the steam-chests off to do this, naturally, so whilst they are off, bevel off the lower side of each slide-valve, to allow the steam free entry into the steam-chest whilst the valve is moving back and forth above the holes. Temporarily replace the steam-chests, and, with the chassis upside down on the bench, put the steam-pipe assembly in position. Run the No. 30 drill through the holes in the flanges, making countersinks on the steam-chests. Remove, drill out the countersinks with No. 40 drill, and tap 1/8 in. or 5 B.A. The whole bag of tricks can then be assembled as shown, using oiled paper gaskets between the contact surfaces ; but, before doing so, make certain there are no drillings, chippings, or any unauthorised oddments left in the steam-chests, passages or pipes. I remember a case where a fitter who wasn't exactly as careful as he might have been, left a small cold chisel in the steam-chest of one of our goods engines. Nothing happened until the engine ran through a junction at a fairly good clip, and shook herself, up a bit; then-well, they had to send out the tool van, disconnect the " works," and pull her home. I took a look inside the steam-chest when the cover was taken off, and one could hardly realise that the torn and damaged portfaces,bent spindles and broken buckles were caused by a bit of steel the size of your little finger. The next instalment will deal with the alternative methods of lubrication, displacement and mechanical, and you can " take your pick," as the kiddies would say.



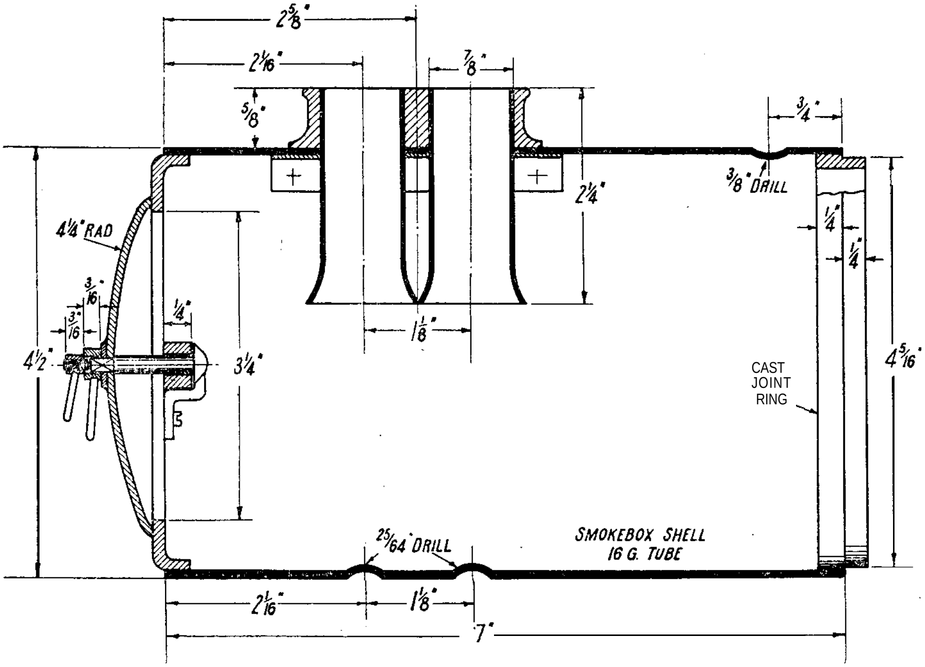
Section of displacement lubricator

“ L.B.S.C.”

” HIELAN’ LASSIE’S ” SMOKEBOX

THE best thing for the barrel of the smokebox is a piece of 16-gauge brass tube, 4-1/2 in. outside diameter, to finish to 7 in. length. It doesn’t matter a bean whether it is best quality seamless, or common brazed-joint stuff; also, any thicker gauge could be used, or even slightly thinner, though I shouldn’t recommend anything less than **18** gauge, on account of making it on the weak side. Other materials can be used ; copper tube will do as well as brass, but it costs more. Steel makes a good smokebox, as long as no water is allowed to remain in it. It naturally gets well heated, and remains free of water all the time the locomotive is at work ; but when the fire is dying out at the close of a run, and the engine is using up her last few pounds of steam, you get a white cloud from the exhaust, and some of it condenses in the now cooled-off smokebox, wetting the ashes in the bottom, and wet ashes are a fine thing to start rusting and pitting. The original “ Maisie’s ” smokebox was made from a piece of steel tube, 1/8 in. in thickness, which I happened to have in stock. “ Bill Massive ” wanted a steel smokebox, and he got one, which certainly was inclined to be massive !

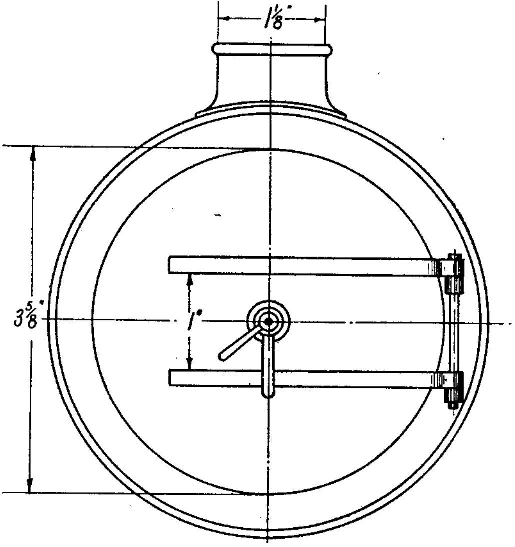
If tube should be hard to get, or even unobtainable (though it shouldn’t be as bad as that), don’t worry; roll up a bit of sheet metal to the diameter required. Butt the edges together, rivet a strip inside about 1/2 in. wide, and silver-solder the joint, if brass or copper. If steel, you needn’t bother about a butt strip at all. Just slightly bevel the edges where they come together to form a vee, and either braze, Sifbronze, or fusion-weld the seam, according to your ability and equipment available. My own preference is Sifbronze. The Suffolk Iron Foundries Ltd., of Stowmarket, who are the makers of that ubiquitous commodity, issue a little quarterly publication called “ Sif-tips,” which they send out regularly to all interested Sifbronzers. There are two “ characters ” in it, Will and Winnie, who describe and illustrate regular engineering jobs by Sifbronzing ; and also another known as George, who is a “ daddy ” with an oxyacetylene blowpipe. This merchant looks on Sifbronze pretty much the same as the cure-all remedy sold by the gentleman who has “ stood in this market place for forty years,” and uses it for every repair he comes across, mending a pair of steel spectacle frames, the baby’s pram axle, lawn mower and garden tools, the family wringing machine, the carving fork, sundry jobs on the gasoline chariot, and so on and so forth. I’m afraid I must confess that Curly is another one of the same kidney, and if there is anything that wants sticking together, and a spot of Sifbronze will do it, well-Sifbronze does it, and that’s that It is hardly necessary to add that



Smokebox for “ Hielan’ Lassie ”

after cutting out the frames of the Brighton single-wheeler " Grosvenor," which I did on my milling machine, using a 4-in. cutter as a circular saw, they were promptly Sifbronzed into the slots in the buffer and drag beams, in less time than it would have taken to cut out and rivet on one piece of fixing angle. Time is very precious nowadays!

Square off both ends of the smokebox barrel in the lathe. If made up from sheet, see that it is nicely rounded. Beginners note : if you drive a circular piece of wood or metal into the end, grip in three-jaw and set to run truly; the outer end can be squared off without any extra support, as the chuck jaws can be tightened down on the barrel without crushing it. Take light cuts with a roundnose tool set crosswise in the rest. Next, mark off the holes for chimney liners, snifting valve and blast pipes. Scribe a line along what will be the top of the smokebox, and make centre dots at 2-1/16 in. and 3-3/16 in. from the end, also another at 3/4 in. from the other end. To get the holes for blastpipes diametrically opposite (aren't I getting posh ?) I use a flexible steel rule which is easily wrapped around the shell, and indicates the exact diameter, so that it is easy to mark off half the amount, and scribe another longitudinal line, on which the distances are set off as shown. If you haven't a flexible steel rule, borrow your fair lady's measuring tape, with a solemn promise not to make it dirty; very important that! Drill all the holes first with a No. 30 drill ; then, by poking a piece of 1/8in. silver-steel (which is usually straight and true) through the liner and blastpipe holes, you can see if they are opposite to one another. If not, correct with a rat-tail file before enlarging the holes to the sizes given. The holes for the liners should be opened out in two stages, finally being drilled 55/64 in. and reamed 7/8 in. Beginners should, after centre-popping, scribe a 7/8in. circle at the location of each liner hole, which will help them to detect any wandering of the drill from the straight and narrow path.



Smokebox front

Chimney and Liners

The chimney is a double stovepipe containing two liners made from 7/8in.brass or copper tube, 18- or 20-gauge. Cut two pieces and square them off to a length of 2-1/4 in. in the lathe. Soften them, and bell one end of each slightly, as shown ; this can be done by driving in a piece of shaped metal or hardwood, or holding them against the edge of a block of lead and making judicious use of the ball end of the hammer head. Cut a piece of 16-gauge sheet brass or copper, 3 in. long and 2 in. wide. Scribe a line down the middle, and set out and drill the two holes for liners, same as described above. Leave the holes slightly small, so that the liners will fit tightly. Bend the piece of metal to the same radius as the inside of the smokebox. Push the liners through from the concave side, so that they are square with the plate, and parallel to each other, projecting 11/16 in. above the plate ; then silver-solder them, using the merest touch of silver-solder on the concave side of the plate, so that there will be nothing on the convex side to prevent it bedding truly against the inside of the smokebox. Put a smear of plumbers' jointing around each liner where it projects through the plate, then insert the whole doings in the smokebox. The liners should go up through the holes in the smokebox shell and the plate fit snugly against the inside. Drill a No. 41 hole at each corner, clean through shell and plate ; countersink on the outside, and secure with brass countersunk screws (3/32-in. or 7-B.A.) nutted inside the smokebox.

As the liners never have to be removed for anything in the ordinary way, they can, if you so desire, be fixed without a plate at all. Simply push them through the holes in the shell, so that they are square with it, parallel and true, and project 5/8 in. Then silver-solder them to the shell. I usually do it that way. On " Tugboat Annie," which has a single large-diameter chimney standing only 1/4 in. above the smokebox (bless those bridges and tunnels !), the liner was pushed through the hole in the crown of the smokebox as above, a flange of 16-gauge metal dropped over it, and a ring of 3/32-in. half-round wire placed on top ; a gentle application of the blowpipe, and hey presto ! we had a nobby-looking doings which was ample for the grate area (and it is great, at that !) and not even Inspector Meticulous himself has found any fault with its personal appearance.

The chimney casting, which our advertisers will be able to supply, will have two cored holes in it. Check these off to make certain that the centres are right, viz., 1-1/8 in. apart, and that they are on the longitudinal centre-line of the casting ; then chuck in four-jaw, base outwards, and bore out each hole until a piece of 7/8in. tube will just push in. The base can be radiused out with a flycutter. This is simply a roundnose tool made from a bit of 1/4in. round silver-steel about 3 in. long. For a holder get a bit of round mild-steel somewhere around 3/4 in. diameter, if your three-jaw has a centre hole which will take that size ; if not, then use the biggest that it will take. The piece of steel should be about 5 in. long. Drill a 1/4in. clearing hole crosswise through it about 1/4 in. from the end, and drill and tap the end for a 1/4in. set-screw. Poke the tool through the crosshole, so that the cutting edge is 2-1/4 in. from the centre of the holder, and secure it by the set-screw ; if you grind a flat on the side of the cutter, the set-screw will get a better grip. Chuck the holder in three-jaw with the cutter overhanging about 3 in. Clamp the chimney-casting under the slide-rest tool holder, level with centres and parallel to bed. Have the lathe running fairly fast ; feed the casting into cut with the cross-slide, and then work it back and forth, parallel to lathe bed. The flying cutter will then machine off the base exactly to the curve of the outside of the smokebox. Warning-mind your fingers ! As about the only type of lathe which would machine the outside of the casting true to profile would be a Blanchard copying lathe, and you don't find *those* in home workshops, the only way to clean up the outside of the casting is by the good old file-and-emerycloth stunt.

Smokebox Front and Door

Castings will be provided for these, and very little machining will be needed. If the hole in the front, or ring, as it is usually called, is clean cast, it need not be touched ; although builders who are a bit fussy may, if they so desire, chuck the casting in three-jaw, or mount it on the faceplate, and bore the hole truly. They can then rechuck, with the bored hole on the inside jaws, and turn the front and the flange at the one setting. An alternative, and perhaps easier way, especially for beginners, is to put the outside jaws in the chuck, and mount the ring on them, gripping by the inside of the flange. The whole front can then be faced off with a round-nose tool set crosswise in the rest, and the flange turned to a tight push-fit in the smokebox shell. The edge should have a good radius. An old flat file with a semicircular " bite " ground out of the end is a good tool for this job. Use it as a hand tool,, resting it on the shank end of a tool projecting from the side of the slide-rest tool-holder, if you haven't a proper hand-rest. I keep a few old-fashioned hand tools (graver, point, round-nose, radius, and right- and left-hand hooks) always ready for use? and often find them handy for finishing off various oddments which would otherwise entail a lot of judicious twiddling of slide-rest handles to produce the same contour, e.g. the top of " Jeanie Deans's" chimney with the undercut lip so beloved of locodelineator F. C. Hambleton. I took special care with that, just to show how I appreciated his excellent drawing.

The door will have a chucking spigot in the middle of the outside, which can be held in the three-jaw, and the edge and contact-face turned at the one setting. You can't turn the outside, on account of the cast-on hinges, so the files and emerycloth will have to come into operation once more. While chucked, centre, and drill a 3/16in. hole through the middle of the door ; reverse in chuck, holding in the outside jaws by the edge, part off the spigot and face the boss truly.

The ring and door may, if desired, be knocked up from brass blanks, or discs cut from 1/8in. sheet brass, the ring needing a circle 5 in. diameter, and the door 3-3/4 in. I have already described the flanging and dishing processes for various other engines described in this series ; machining is carried out as above, a chucking-spigot being turned from 1/2in. round brass rod, and soldered to the concave side of the dished and drilled door blank, so that the outside can be turned and the contact edge trued up at the one setting. The hinge straps are made from pieces of 18-gauge strip steel, brass or nickel-bronze ; the ends are bent into eyes and silver-soldered, the hinge straps being riveted to the door by bits of domestic pins. The built-up work looks nice if carefully done ; but life is short, and good castings eliminate a lot of time-absorbing labour !

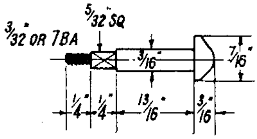
Dart and Crossbar

The dart is made from a bit of 7/16in. round mild-steel chucked in three-jaw. Face the end, and turn down 1-5/16 in. length to 3/16 in. diameter ; further reduce 1/4in. of the end to 3/32in. diameter, and screw it 3/32-in. or 7-B.A. The next 1/4in. is filed square. Part off to leave a head 3/16in. wide. File it flat, flush with the 3/16in. stem, and then shape it as shown in the illustration. The key is a 3/16in. slice parted off a piece of 5/16in. steel rod ; drill a 5/32-in. hole through it and file it square to fit the squared part of the dart. The locking-nut is a 3/16in. length of 3/16in. steel rod drilled and tapped to suit the thread on the end of the dart. Both are drilled through the side with a No. 48 drill at a slight angle, tapped 3/32-in. or 7-B.A., and have pieces of 3/32-in. silver-steel screwed in, for use as handles. Round off the outer ends, or you'll be hearing a few compliments from the driver and fireman !

The crossbar is a simple job. Cut two pieces of 1/8in. by 1/4in. mild-steel, each 4 in long ; clamp together, and drill a No. 41 hole 1/2 in. from each end. Chuck a bit of 1/4in. round rod in the three-jaw ; face, centre, drill No. 41 for about 3/4 in. depth, and part off two 1/4in. slices. Put them between the bars, opposite the holes;, to act as spacers ; poke two 3/32-in. by 5/8in. iron rivets through the lot, and rivet up. Nobody ever sees this component, so there's no need to worry about exhibition finish !

The crossbar is supported on two brackets made from strips of 16-gauge sheet-steel, 1/4 in. wide, attached to the inside of the smokebox front by a single 3/32-in. screw in each ; see section. The location of these is obtained from the actual job. Put the dart through the hole in the middle of the door, with a 3/16in. steel washer on the outside, then the key and locking handle. Put the door in position on the ring, put the crossbar over the head of the dart on the back of the ring, adjust it so that it is centrally located across the " big hole," and tighten up the locking handle. Check off to see if the door is still in the middle of the ring ; if so, set your brackets up against the underside of the bar, mark off the screwholes, drill and tap them, and put the screws in, filing off any projection on the outside of the ring.

Turn the whole issue over, and mark out the position of the hinge lugs under the bosses on the ends of the straps ; see front view. Centre-pop 1/16 in. below the straps, drill No. 44 and tap 6-B.A., or No. 40 and 5-B.A. The lugs themselves are another kiddy's practice job. Chuck a bit of 1/4in. by 1/8in. rod truly in four-jaw, turn down the end for 1/8in. length to 7/64in. or 1/8in. diameter, according to how you tapped the holes, and screw it to match. Part off 1/4 in. from the shoulder. Round off the ends with a file, remove door, and screw in the lugs. Drill the bosses on the ends of the dummy hinge straps on a cast door, with No. 48 drill ; if the door is built up, the bosses won't need drilling, as they will be formed by the bent-round ends of the straps themselves. Replace door, and screw it up in its proper position-; poke the 48 drill down the holes in the bosses, and carry on through the lugs. The hinge pin is a piece of 15-gauge spoke-wire or silver-steel, with the end slightly riveted over so that it won't fall through. If you want an extra posh appearance, screw a weeny bit of steel rod on the end, and turn it into a little flat head as shown in the illustration. Don't out the completed ring-and-door assembly in the front of the smokebox " for keeps " yet ; this can be done after the boiler is erected and all the steam pipe connections made inside the smokebox, which is easier work with the front unobstructed.



Dart

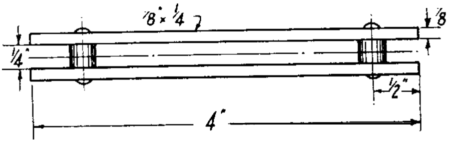
Joint-ring

Castings will be supplied for the joint-ring, which is merely a ring 1/2in. wide, turned in two steps. If your chuck isn't big enough to hold it on the largest diameter the inside jaws will take, put the outside jaws in, and hold the casting on the outside of those, similar to the recommended way of holding the smokebox front. The two steps can be turned at the same setting. Use a roundnose tool first, and turn the whole outside surface of the ring to fit tightly into the smokebox barrel, the diameter being approximately 4-3/8 in. Then take another 1/32in. off half the width with a knife tool, to fit the end of the boiler barrel, which should be 4-5/16 in. If turned at the same setting, the steps should be exactly concentric ; and when boiler and smokebox are connected, they should line up exactly.

" Juliet "

Displacement Lubricator

Beginners who are shy of tackling the job of making a weeny mechanical lubricator can use the simple displacement pattern shown in the assembly view of the steam and exhaust connections, illustrated along with the last notes on " Juliet ." A displacement lubricator works very well if the screw-down valve is properly adjusted ; its principal failing is a tendency to " gulp." The cause of this is easily explained ; for beginners' benefit I will repeat that when the engine is running there is naturally the same pressure in the lubricator tank as in the steam-chests. When the regulator is suddenly closed, steam pressure in the chests falls to " below freezo," as the kiddies would say, on account of the pumping action of the pistons ; and the pressure in the lubricator immediately forces out any oil above the outlet, into the steam-chests, helped in its nefarious work by the partial vacuum in same. As soon as the regulator is reopened, the surplus oil in the steam-chests is shot out of the chimney with the exhaust, and the driver usually gets a free and unsolicited beauty treatment. Engines provided with snifting valves are not so bad as those without, as the pistons do not suck the oil ; but the pressure in the lubricator still takes action. The provision of a check-valve between lubricator and steam pipe is a doubtful remedy, as the valve frequently sticks on its seat and prevents oil reaching the cylinders when running. However, if the lubricator valve is carefully adjusted, gulping can be greatly reduced; and careful handling of the regulator can make it negligible.



Crossbar

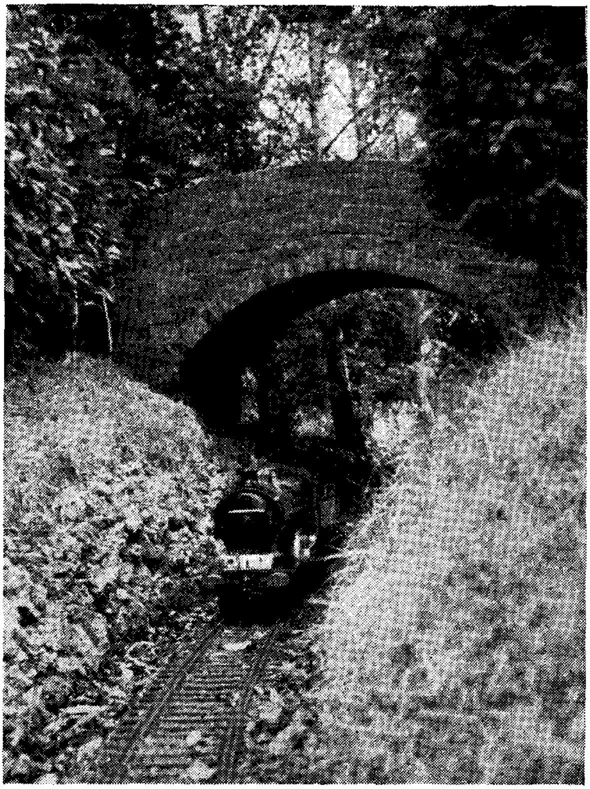
The oil tank is simple a piece of 3/4in. copper tube, about ao-gauge, squared off each end in the lathe to a length of 2-7/8in., with a 16-gauge sheet-copper disc driven tightly into each end. A 3/16in. hole is drilled right across the middle ; a 1/4in. hole in the top, and a 1/8in. hole in the bottom. A 1-1/4in. length of 1/4in. pipe, with a few threads on one end, is pushed into the top hole. A bent piece of 1/8in. pipe, also with a few threads on the end, goes in the bottom hole. The valve goes through the middle. To make it, chuck a piece of 3/16in. brass rod in the. three-jaw, face the end, and part off a piece 1-1/8in. long. At 1/2in. from one end, drill a 3/32in. hole right across the middle. Chuck in three-jaw with the short end outwards ; centre and drill with No. 55 drill until you break into the cross-hole. Let the drill go on into the other side for about 3/16in. or so ; then open out with No. 48 drill as far as the cross-hole, and again with No. **41** for about 1/4 in., to give clearance for the valve pin. Tap the remains of the No. 48 hole with 3/32in. tap, letting same run into the cross-hole. Screw the end about 3/16 in. down, with 3/16in. by 40 die in tailstock holder.

Reverse in chuck ; centre deeply, and drill down with No. 40 drill until you meet the 55 hole. Take great care not to " overshoot the platform," and break into the cross-hole, or it is good-bye to the valve-seat, and the ceremony thus far will have to be repeated. Put about 3/16 in. of outside thread on this end also. The valve pin is made from 3/32in. round steel; either rustless- or silver-steel will do ; in fact, it doesn't matter if bronze, or even brass, is used, as the valve, once correctly set, need never be altered. Screw it for about 1/2 in., with a 3/32in. die in the tailstock holder ; then turn away the threads for about 3/16 in., and form a cone point on the end. This needn't be turned ; a couple of sweeps across the end, with a fine file held at an angle of about 45 deg. makes a perfect point. I've made scores of them that way. Cut off the pin about 7/8 in.

(Continued on page 132)

The charms of steam have no rival in our sphere of activity, but there is a little anxiety as we turn our attention to oil-burners on the basis of necessity rather than economy ; that is, as it affects the larger miniature locomotives. The position appears so antithetical after having striven in recent years to break away from liquid in favour of solid fuel.

Be not depressed, however, as there is a new field to conquer-spray burners in place of the vaporising type and the utilisation of more viscous fluids than hitherto employed. Model engineers have not neglected this subject, but there has been very little development. A fairly up-to-date effort was reported in tne issue of November 28th, 1935.


At Porch Point

It is, indeed, fortunate for us that the locomotive type of boiler has proved adaptable for oil-firing. Maybe, on our small editions we shall follow the full-size convert in needing a relatively sharp blast to obtain free steaming. We shall see, in due time, and be able to compare results with the vaporising forms which seem to favour a blast softer than customary on a coal-fired engine. Such points as firebrick protection and ensuring complete combustion before the flames reach an impact surface need to be taken into account. The chief advantage of oil fuel is its favourable calorific value and enhanced evaporative power. But all the gain may not be realised owing to the need, in certain cases, of providing steam to operate the burners.

Provided that the mechanics of an oil-burning system are planned on the right lines, success should be possible. On the subject it would be nice to have a symposium similar to the one we had a few months ago on ground-level tracks.

The little 7-1/4in. gauge tank engine which was illustrated on page 491 of volume 93, will now come into its own as an experimental unit for trying out various oil burners and to ascertain if water tubes are desirable in the firebox when liquid fuel is used.

These experiments are a complement to the 101 other things that can be tried out. Has anyone yet tried " cab travel" in sub-zero weather, for example? It would be interesting to see what happens, for, presumably, efficiency drops considerably if only because incoming air has to be heated up to combustion temperature, not to mention the extra radiation losses our subject is not exactly off the track, but——

The day's work was done and, lulled by various rhythmic engine noises, sleep followed in the beautiful setting of a friendly world of locomotives. Should you consider the title of this article presumptuous, try and picture the'emotion at the outset ; and should your forgiveness be forthcoming, attempt its expression as a contribution to the suggested symposium. It would be most welcome.

" L.B.S.C."

(Continued from page 129)

from the point, and file a square on the end. This is furnished with a little handwheel, 3/8 in. diameter, turned from 3/8in. brass rod ; another kiddy's practice job needing no description, as is also the little gland nut made from 1/4in. hexagon rod.

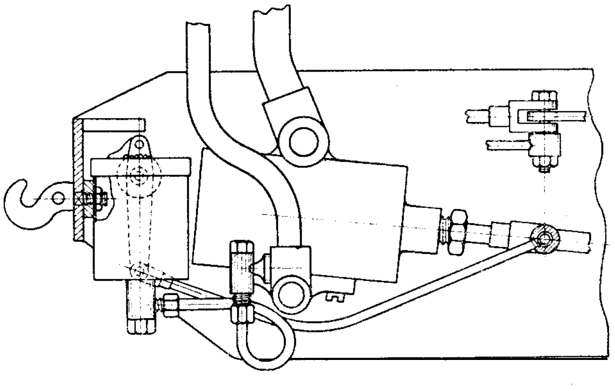
All the joints-ends, valve, and top and bottom tubes-can be silver-soldered at one heat. Pickle, wash off, clean up, and pack the little gland with a strand of graphited yarn. Attach the lubricator to the 1/8in. pipe with union nut, projecting from the front of the steam tee, as shown in the assembly drawing ; the tank should fit tightly between the frames. It may be held by a 1/8in. set-screw running through a tapped hole in the frame at either side. All that remain are two little caps as shown in the illustration, one made from 5/16in. hexagon rod, for the filling tube, and one made from 1/4in. ditto, for the drain pipe.

“L.B.S.C.” on Suggested Variations for “JULIET”

JUDGING from correspondence? and the amount of castings and material sold by various advertisers, this little simple locomotive would appear to be a winner, and a large number of them will eventually take the road ; but some of the before-mentioned correspondence has caused your humble servant to chuckle a little ! Before starting on the “ serial,” I received many requests to describe a 3-1/2in. gauge locomotive of the absolutely simplest form of construction, combined with efficiency, to haul living loads on a small continuous line which could be accommodated in the average suburban garden. Also, to try and work it in between the instructions for building the “ Lassie,” so that any intending builders could get busy right away. Well, I did all that, as you know ; but, bless your hearts and souls, no sooner do some of the very folk who asked for the simplest and quickest job, get their frames erected and the wheels on, than they immediately proceed to ask for elaborations-1 guess I’ve made the job too easy ! It was mentioned early in the description, that a link-motion could be fitted, by adding a few extra parts? and I said this variation would be described if required. Any amount of letters asking for the link-motion, have come to hand ; and all being well, and no objections raised by our worthy friend of the blue pencil, this will appear in the next instalment of “Juliet.” I had intended to hold it over until the completion of the engine as originally designed ; but builders who want to fit link-motion, say they might as well do it before putting the boiler on the chassis, and I’m here to try and please all that I can, so it’s your call.

Walschaerts or Baker Gear ?

However, some builders have asked for details of a complete Walschaerts gear, preferring outside motion to one between the frames ; and others who are rather tickled or intrigued by the simplicity and ease of construction of the little nest of rods and links, designed by the Baker who didn’t know what a BU was (lucky fellow !) want to know if they can Bakerise “ Juliet.” It could be done, but I don’t recommend it. For the start, both Walschaerts and Baker gears are primarily intended for cylinders with valves on top, whilst “ Juliet’s ” are between the frames. That means having fresh cylinders altogether, necessitating a new design of cylinder, and completely altering the steam and exhaust pipe arrangements. True, the big 4-6-2 “ Bessborough ” of the old Brighton line, and the Baltic tanks, had outside Walschaerts gear with cylinders having steam chests inside the frame ; but this involved a rocking shaft and pendulum levers for each cylinder, and if applied to “ Juliet ” would not only cause needless complication, but introduce more joints, and sources of lost motion, due either to wear, bad fitting, or both. If a beginner makes a poor job of the solitary pin joint in the loose eccentric gear, it isn’t going to make any appreciable difference to the running of the engine ; but if he “ fits ” all the joints of a Walschaerts or Baker gear, plus the rocking shaft and its connections, in a similar manner, the locomotive would cut a pretty fine caper when called upon to do a spot of real work. My honest advice to all who wish to reverse the engine with a lever, and notch up when running, is to fit the simple link-motion which I shall describe.



How w erect lubricator

Increasing Dimensions

Another batch of builders say the engine looks too tiny for 3-1/2in. gauge, and suggests a bigger boiler and cylinders. This is entirely a matter for personal choice ; and those who prefer, can convert her to narrow-gauge, making her the equivalent of a 3 ft. 6-in. gauge engine instead of 4 ft. 8-1/2in. The cylinder bore could be enlarged as big as the castings would allow-say, to 1-1/8 in.-and instead of the small “ standard gauge ” boiler shown on the general arrangement drawing, a larger one, with a barrel 4-1/4 in. or 4-3/8 in. could be used. I believe some of our advertisers still have in stock, tubes of this diameter, as specified for “Bantam Cock” and “ Maisie.” This diameter of boiler would need a wide firebox, with a foundation ring either sitting on top of the frames, or let into a recess in them, something after the style of the ten-coupled edition of “ Ada.” Another suggestion was, in addition to the above, lengthening the frames and fitting another pair of wheels, making her an 0-6-0. I don’t quite see the idea of this at all, because I recently offered an engine of this type in these notes. to wit. " I'. V. Baker;" and anybody needing a six-coupled engine, had better tackle that one and be done with it ; they would have no alterations to worry about, as the 0-6-0 already has cylinders with valves on top, Baker gear and a bigger boiler. Then probably they would be writing to me and asking how to fit " Juliet " cylinders to it-such is the perversity of human nature ! I also don't see the slightest need of making "Juliet " into a tender engine, because she carries plenty of water in the side tanks, and it is easy enough to carry a little coal in a box on the front of the passenger car. The engine. as she is being described, is ideal for a kiddy who is learning how to handle a small steam locomotive ; for the open-backed cab, and the absence of a tender, bring the handles within easy reach of short arms, and a youngster is not so likely to overbalance, or tip up the car.

A few readers want to know if an oil-fired water-tube boiler would steam sufficiently well to haul passengers. Yes, it would, with my recommended valve setting, and I'll give an outline of such a boiler if required ; but the whole engine would get so confoundedly hot that she would probably be very uncomfortable to drive. The only saving grace would be that the feed water would automatically become very hot by absorbing some of the heat otherwise wasted through the boiler casing. A number of other variations were suggested, but as the old saw puts it, " Sufficient for the day is the evil thereof," and so let's get on with a few hints about mechanical lubrication, for those who desire to fit same.

Mechanical Lubricator

Although the displacement lubricator with regulating valve, previously described, would always ensure that the cylinders and valves got plenty of oil, the feed is not always regular, for reasons I have already explained ; so here are the necessary details of a mechanical lubricator for those who like to take the trouble to make and fit it. Incidentally, my little Brighton engine " Grosvenor," will have one of exactly the same pattern, which is going one better than her big sister. As I explained very fully, for beginners' especial benefit, how to make all the components in the notes on " Petrolea," and again expounded fairly explicitly in dealing with the " Lassie's " twin-pump gadget, there is hardly any need to set down the complete ritual again ; so I propose just to run through the job briefly. The illustrations are practically self-explanatory, and the veriest Billy Muggins should have no difficulty in making up and fitting the lubricator, which is as simple as the toy oscillating-cylinder steam engines with which our late enemy Jeremiah " invaded " the country before having a shot at doing the job in person. If Terry's love for kiddies had been as great as his skill in making toys for them, the world would have been saved a great deal of misery.

Oil Container

The tank can be made from 18-gauge brass or copper ; cut a piece 1-3/16 in. wide and 5 in. long, bend it into a rectangle 1-1/2 in. by I in., stand it on another bit (16-gauge if you like, to make a stronger bottom) a shade larger, silver-solder all round the joint and up the corner, and file the bottom flush with the sides. Drill a 3/16in. hole in the middle of the bottom, and another one 3/16in. from the top, on the centre-line of one of the shorter sides. A lid can be made by flanging a piece of sheet brass or copper over an iron former, measuring I in. by 1-1/2 in., same as you would flange a boiler plate ; or alternatively, by cutting out a piece of sheet-metal 1-3/8 in. by 1-7/8 in., taking a 3/16in. square piece out of each corner, and bending 3/16 in. of the edges to a right-angle, forming a sort of shallow tray. The corners may be silver-soldered, or left just as they are.

Oil Pump

The stand for the pump is made from a piece of 5/16in. square brass rod, squared off in the four-jaw to a dead length of 1-3/16 in. Centre one end, and drill and tap the hole for the stem of the delivery check valve. The stand can then be milled, or sawn and filed, as shown in the illustration, which gives all the particulars, also drilled for trunnion-pin, bearing, and ports. Beginners should note that these holes must go through square with the working face : so if you haven't a drilling machine, use the lathe, with the drill in three-jaw, and the stand held against a drilling pad in the tailstock barrel. Marking-out tips : scribe a line down the middle of the stand, and set out the location of the trunnion hole, 3/8in. from bottom. Set your divider points 1/4 in. apart ; and from the trunnion hole, strike an arc across the lower rubbing face. Set out the ports on the arc, 1/16 in. either side of the centre-line. Don't alter the dividers, but when marking out your pump cylinder, scribe a centre-line as before, dot off the location of trunnion pin 21/64 in. from bottom, then with one point of the dividers in the centre-pop, strike a little arc cutting the centre-line. Dot the intersection, and that is where the port is drilled. The ports should then line up perfectly ; and don't forget that the right-hand one is drilled right through into the hole in the bottom of the stand, whilst the left-hand one has a little groove cut from it, across the rubbing face, to the bottom, to allow oil to get into the pump cylinder.

After squaring off the ends of the pump cylinder in the four-jaw, set out on one end, the location of the bore, and make a centre-pop. Rechuck with this running truly; then drill No. 33, open out and tap for the gland? finally running a 1/8in. reamer through the remains of the No. 33 hole. A piece of 1/8in. ground rustless steel, or bronze rod, should fit exactly in the reamed hole ; the slide-rule merchants will say " 'as 'ow it shouldn't," but the fact remains that both my t-in. reamers mike up correctly to 0.125 in.. and a bit of rod miking up to the-same measurement is a lovely fit in a hole reamed by either of them, so that's that ! The length of the ram is 7/8 in. ;the cross-hole for the crankpin should be drilled No. 48, and 3/4 in. from the bottom. The gland is turned from i-in. hexagon brass rod, and screwed 7/32 in. by 40; the trunnion pin is a 7/8in.length of 3/32in. silver-steel, screwed both ends, as shown. It must be

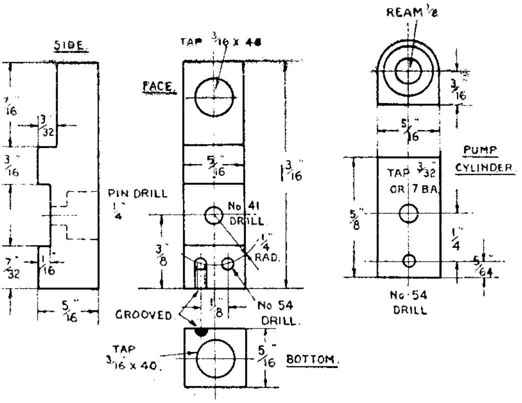
exactly at right-angles to the cylinder rubbing face. The spring is wound up from 24-gauge tinned steel wire, and secured by an ordinary commercial nut.

Operating Gear

The bearing for the crank spindle is a kiddy's practice job, being merely a piece of 5/16in. hexagon brass rod held in chuck and faced, centred, and drilled down about 1 in. with No. 41 drill. Turn the outside for 27/32 in. length to 3/16 in. diameter, screw 3/16 in. by 40, and part off to leave a 3/32in. head. Make a nut to suit. The crank spindle is a 1-3/8in. length of 3/32-in. silver-steel, screwed both ends, and furnished with a little crank made from a 1/8in. slice. of 3/8in. round brass rod. The crankpin is a bit of 15-gauge spoke-wire, screwed into a tapped hole in the crank as shown, using 9-B.A. tap and die. The ratchet wheel is 7/16 in. diameter, 3/32 in. wide, with 35 teeth ; as Tom Glazebrook has now no time to make these, Dick Simmonds will supply. The wheel is drilled No. 43, and pressed on to the spindle, so that when poked through the bearing, and the crank screwed on, there is about 1/64 in. end-play.

Pawls

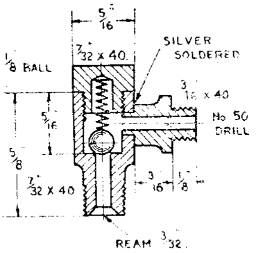
The ratchet lever is filed up from 3/32in. by 1/4in. strip steel, or a bit of 3/32-in. bright sheet. As there is enough headroom for the moving pawl to be placed above the ratchet wheel, I have specified that position, as it gives more room for the stationary pawl on the side of the narrow oil tank. Both pawls are filed up from 3/32-in. steel, and case-hardened. The moving pawl works on a screw with a full 3/32 in. of plain part under the head, and slightly riveted over where it projects through the lever. A 1/16in. screw is tapped into the end of the pawl, and connected by a spring to the lever as shown, the bottom end either being fixed by another screw, or hooked into a 1/16in. hole in the lever. The stationary pawl is mounted on a little stud turned from 3/16in. steel rod ; the end carrying the pawl is turned down to 3/32 in., put through a No. 41 hole in the pawl, and lightly riveted over. The other end is screwed 8-B.A., and goes through a No. 43 hole in the tank, with a nut on the inside. Both pawls must be perfectly free on their pivots, and the ratchet-lever should also be free on the spindle, without side play, when the nut is tight home.



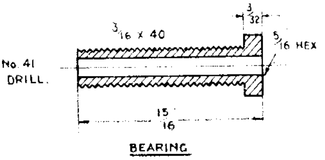
Pump stand and ***cylinder***

Clacks

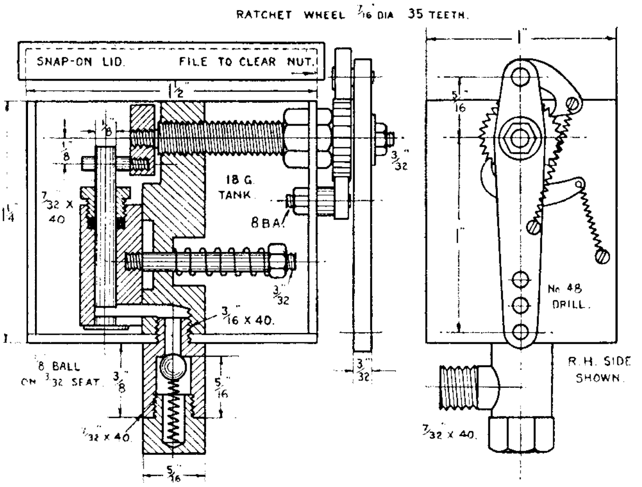
Two clacks, or check valves, are needed, made from 5/16in. brass rod. Both the insides are alike. Chuck the rod in three-jaw, face, centre, drill down about 3/4 in. depth with No. 43 drill, open out to about 1/4 in. with 3/16in. drill, and bottom the hole to 5/16 in. depth with a D-bit. Tap 7/32in. by 40, and. don't let the tap scrape the seating; countersink slightly, part one off 5/8 in. from the end, and the other 1/2 in. Reverse the 5/8in. one in chuck, turn down 1/4in. of the end,



Delivery check valve



Spindle ***bearing***



Mechanical lubricator for " Juliet "

to 7/32 in. diameter, and screw 7/32 in. by 40. Countersink the end, and poke a 3/32-in. reamer through the hole. The other end of the 1/2in. one is turned down for 1/8 in. length to 3/16 in. diameter, screwed 3/16in. by 40, and reamed as above. A 5/32-in. hole is drilled in the side of each. A 7/32-in. by 40 countersunk union nipple is silver-soldered into the hole in the 1/2in. one, and a 3/16in. by 40 screwed flange fitting, as shown in the section, fitted to the 5/8in. one. Both caps are turned from &-in. hexagon brass rod, and drilled No. 30 ; the springs are wound up around a bit of 3/32-in. rod, from steel wire of about 30 gauge. They don't need to be excessively strong ; merely enough to retain the balls on the seatings at all times, as they tend to " float " in the heavy cylinder oil, and would not seat quickly enough to prevent back flow of the oil, if left without assistance.

Assembly and Erection

Beginners note-to assemble the pump, true up stand and cylinder rubbing faces as described for slide valves etc., and pack the little gland with a strand of graphited yarn. Screw in the trunnion, put it through stand, and put on spring and nut. Stand the whole doings in the tank, and screw the short clack into the stand through the hole in bottom of tank. Poke the bearing through hole in side of tank, put lock-nut on loosely, then screw bearing into stand until the head touches side of tank; then run lock-nut back against tank side, and tighten up. Put the crankpin through hole in ram, hold crank opposite bearing, push spindle through same. and screw into crank. Put on the ratchet lever; tighten up the delivery check-valve under tank, and Bob's your uncle. If some heavy oil is put in the tank (I use "Vacuum 600 W," or " Cyltal 81,"but any good cylinder oil for superheated steam will do) and the ratchet wheel turned by hand, it should be quite impossible to prevent oil coming out of the union nipple by pressing your thumb on it, as these lubricators will pump to over 400 lb. pressure.

Erection is easy. Drill and tap the steam tee 3/16 in. by 40-take the whole bag of tricks off to do this, and be sure to blow all the chippings out-and screw in the longer clack. Cut a segment 1-5/8in. long, out of the top of the buffer beam, so that you can get at the lubricator for filling purposes. To hold the lubricator in the position shown in the illustration. If you haven't already made the draw-hook, drill a No. 41 hole 1 in each side of the draw-bar hole, and on a level with it countersink them. Solder a piece of brass rod' 1-1/2 in. long, 1/8 in. by 3/8 in. section, to the front of the lubricator tank, just a weeny bit below the lid, as shown ; then hold the lubricator in position, run the 41 drill in the holes in beam, making countersinks on the brass rod. Remove, drill the countersinks No. 48, tap 3/32 in. or 7 B.A., be careful to clear any chips out of the tank, replace, and secure by countersunk brass screws. When you have made the draw-hook, the stem of this can pass right into the tank through a No. 30 hole, and the nut put on inside the tank, thus killing two birds with one shot, by fixing the hook and providing extra support for the lubricator. The unions on the two clacks are then connected by a short piece of 3/32in. pipe, having a union cone and nut on each end ; the pipe should have a curl in it as shown, both for ease of fitting, and keeping the pipe as cool as possible.

A drive for the lubricator is easily arranged by connecting the ratchet lever to the nearest valve-spindle by a piece of 13-gauge spoke wire, or silver-steel. A bush or bearing is made bv chucking a piece of 5/16in. bronze rod, centring and drilling No. 30, and parting off a slice about 3/16 in. in thickness. Drill and tap a hole in the side, 3/32 in. or 7 B.A., screw one end of the rod to suit, and attach bush as shown. The bush may be silver-soldered to the rod, instead of screwed, if you so desire. The other end of the rod carries a little fork or clevis, made same as the forks on the valve-spindles, but from 1/4in. square rod. This is screwed to the end of the spoke-wire connection, and attached to the ratchet lever by a 9-B.A. screw with 3/16 in. of plain part under the head. The outer side of the fork is drilled No. 48, and the inner side tapped 9* B.A. : or vou can drill both sides No. 48 and use a bolt, with nut on the inside, just as you prefer. The rod connecting the lever to the valve-spindle must be bent as shown, to clear the " obstructions on the line," and a 1/8in. bolt passes clean through valve fork, eccentric-rod, and bush. as shown in plan. This can be made from 1/8in.silver steel, shouldered down to 3/32 in. at each end, and furnished with commercial nuts.

The length of the rod, and its connection to the ratchet lever, is best obtained from the actual engine. With the loose eccentric gear, and a travel of 3/8 in. on the valve-spindle, the fork may be connected to the bottom hole, and this should ratchet one tooth for every revolution of the driving wheels. With the link-motion, the valve travel will shorten as the engine is notched up, and the fork will have to be connected higher up the ratchet-lever ; so put the reversing lever in next notch to middle, after the gear has been made and erected, and couple the fork to the hole that allows the lever to ratchet one tooth per revolution when the valve-gear is notched up to this running position. In full gear, it may ratchet two teeth per turn, but this will not matter, as the gear can be notched up almost as soon as the wheels begin to turn.

With a mechanical lubricator it is a simple job to provide a means of introducing what the enginemen call a " dope," that is, a small charge of oil in the cylinders to help starting from all cold. Drill a 1/4in. clearing hole through the side frame, opposite the lubricator spindle, to take an extension handle. This mav be a piece of brass rod with a cross handle or wheel at one end, and the other either drilled and tapped to screw on the spindle outside the nut, or formed like a box spanner to go over the nut. For this, all you do is to drill a hole in the end of the rod. same size as the nut over corners : put a nut-in, and hammer down on the flats; which will make the hole go hexagon-shaped. To use, simply insert the extension, connecting to spindle, and turn a few times. You will feel if the lubricator is pumping, as there will be distinct resistance when the oil forces its way past the spring-loaded ball valves in the clacks.

“ L.B.S.C.”

LINK MOTION FOR “JULIET”

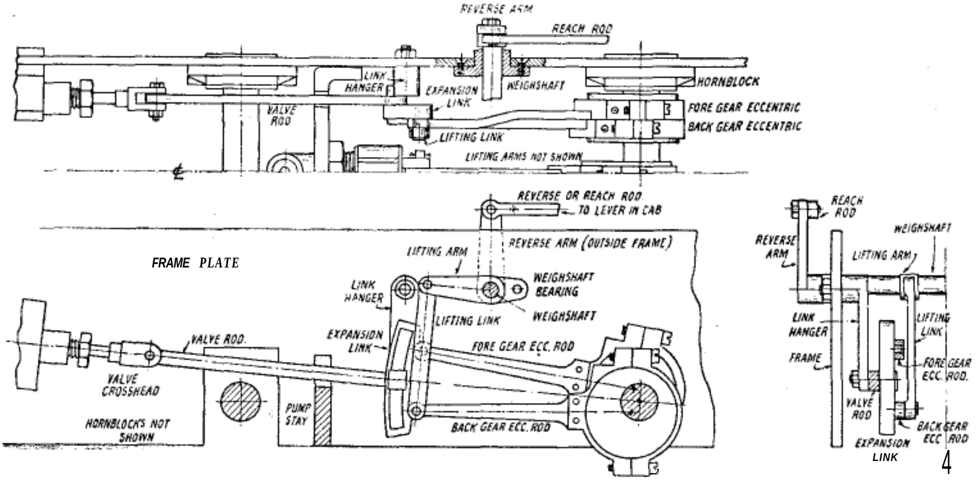
YOU will recollect that “Juliet” made her bow under the sub-title of “the simplest yet” ; well, in the accompanying illustrations of a suitable link motion reversing gear for her, you will see that I have done my best to keep the whole bag of tricks down to the rock-bottom of simplicity, with due regard to efficiency. The Stephenson link motion—which, incidentally should, by the good rights, be called the Williams-and-Howe link motion, after the good folk who first thought of it—is quite a simple gear, despite the efforts of various people to surround it with an aura of mystery Anybody who wishs to go fully into the whys and wherefores, should borrow a copy of Colburn’s ***Locomotive Engineering*** from their library, and read what Zerah of that ilk has to say about it ; for practically all the journalistic efforts on the same subject that have since been written, are paraphrases of the notes by the clever old engineer mentioned. Another good dissertion on the link motion, is contained in Forney’s ***Catechism of the Locomotive,*** and is much easier to digest than Colburn’s. The above information may be useful to beginners.

As your humble servant takes an unholy delight in debunking and de-mystifing, there is mighty little to say about “Juliet’s” link motion. The veriest Billy Muggins can grasp how the loose eccentric gear operates ; in the present arrangement, we fix the eccentric on the axle, instead of leaving it loose, and set it O.K. for going ahead. We put another one beside it, instead of a stop collar, and set that merchant O.K. for backward motion. The ends of the eccentric-rods are connected to the ends of a slotted link; and in the slot of the link is a die-block, coupled to the valve rod which operates the slide-valve. By dropping the link to its lowest position, the die-block is brought opposite to the forward eccentric, and naturally follows its movement, imparting same to the valve, and so the engine goes ahead. By lifting the link, the die-block is brought opposite the backward eccentric, and the movements of the valve are reversed, so the engine goes backward. If the link is not raised or lowered to its full extent, and the die-block is not exactly opposite the end of the eccentric-rod, it is obvious that its movement will be less, thus restricting the movement of the valve, and cutting off steam earlier in the stroke. That, brother beginners, is an explanation of the Stephenson link motion in a nutshell ; terribly complicated box of tricks, don’t you think ?

In order to keep “ Juliet’s ” arrangement as simple as possible, all forked joints, with the exception of the ends of the lifting arms, have been dispensed with. The end of the valve rod is carried on a pin in a swinging lever called the link hanger ; and as the die-block is mounted alongside it on the same pin, naturally they must work in unison. The ends of the eccentric-rods are not forked, but have plain eyes which work on pins fixed in the links ; and Same are lifted and lowered by lifting links attached to the lower pins, which are extended for this purpose. You couldn’t have anything simpler, or easier to make and fit; and the proportions of eccentric-rods and links are exactly proportionate to those used on some of the latest Great Western engines, and what is good enough for Swindon, is good enough for “ Juliet ! ” Now to construction.

Holes in Frame

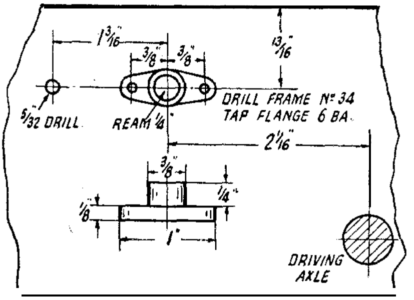
There are four holes needed in the frame, to



Simple link motion for “Juliet ”

take the link hanger bolts and the weighbar shaft bearings ; better drill these first. Note carefully : draw a line along the top of frame, between the wheels, 13/16 in. from the upper edge ; at 2-1/16 in. from the vertical line of the driving axle, make a centre-pop, and another 1-3/16 in.farther ***along.*** Drill the former 3/8 in., and the latter 5/32 in. Tip for beginners : drill them all with No. 30 drill first, put a bit of straight 1/8in. wire through each pair, and you'll see, by the ***way*** the wire lies across the frames, if you have drilled them parallel. If not, correct with a rat-tail file before enlarging to correct sizes. On the same line, at 3/8 in. each side of the 3/8in. holes, drill two No. 34 screw-holes, as shown ; file off any burrs.

Make the weighbar shaft bearings and fit them, at the same time. Castings may be available ; if not, chuck a bit of 1-in. brass rod, face, centre, and drill about 1/2 in. depth with 15/64in. or letter " C " drill. Turn down 1/4 in. of outside to fit hole in frame, part off at 3/8 in. from the end, reverse in chuck, poke a 1/4in. reamer through the hole, and skim off any burrs. File the flange oval, place in frame with flange inside, hold with toolmaker's cramp, run the No. 34 drill through holes in frame, making countersinks on the flange, follow with No. 44, tap 6-B.A., and put screws in ; but don't fix "for keeps" until the weighshaft is erected.

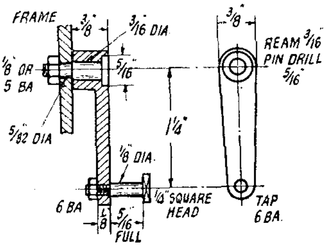


Weighbar bearing

Link Hangers

File up two pieces of 1/8in. by 3/8in. flat steel to shape shown, and drill two No. 44 holes at 1-1/4 in. centres. Chuck a piece of 3/8in. round steel rod, and turn a 1/8in. pip on the end, to a tight fit in the hole in larger end of hanger. Part off at 1/4 in. from shoulder, drive the pip into the hanger, and braze or silver-solder it. Clean up, chuck the boss in three-jaw, face off any of the pip left sticking out from the face of the hanger, centre, drill with No. 14 drill, poke a 3/16in. reamer through, and pin-drill the hole with a 5/16in. pin-drill to a depth of 1/16 in., like the leading boss of a coupling-rod. Tap the hole in the other end 6-B.A. For the fulcrum pin, chuck a bit of 5/16in. round steel rod in three-jaw, turn down 5/8 in. length to 3/16 in. diameter, a nice working fit in the hole in the link hanger boss. Put the hanger over it, boss outwards, and turn down the projecting bit to 5/32 in. diameter with a knife tool, until the tool almost touches the boss. This is an easy way of getting the working clearance without any measuring. Further reduce the end to 1/8 in. diameter, leaving about 7/64 in. of the 5/32in. portion ; screw 1/8 in. or 5-B.A., and part off the pin to leave a head 1/16 in. wide.

The lower pin can be turned from a bit of 1/4in. square steel chucked truly in four-jaw. Turn down 9/16 in. of it to 1/8 in. diameter ; further reduce a bare 1/4 in. to 7/64 in. diameter, screw 6-B.A., and part off to leave a 1/16 in. head. If square stuff isn't available, use 3/8in. round, and file the head square.



Link hanger

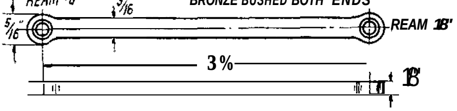
Valve -Rod

This is merely a sort of miniature coupling-rod filed or milled from 1/8in. by 5/16 in. mild-steel, to the shape and sizes given in the illustration. Both ends are drilled 5/16 in. and bushed with gunmetal or bronze, the bushes being reamed 1/8 in. after being pressed in.

Eccentrics, Straps and Rods

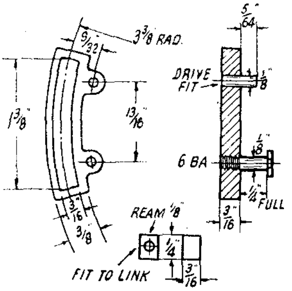
The four eccentric-straps are made exactly as described for the loose-eccentric gear, so there is no need for useless repetition. The only differences in the sheaves are, that there are four of them, and in place of the stop pin, each one is drilled and tapped for a set-screw. Drill a No. 40 hole lengthwise through the widest part, as shown in the section, and open out to half its depth with No. 30 drill, tapping the remainder 1/8 in. or 5-B.A.

The rods are fitted to the straps in an exactly similar manner to that described for the loose eccentric-rods, but they are shorter ; the ends are only 1/4 in. diameter, so that they will clear the head of the die-pin. Two of them are straight, and two are set over 1/8 in., as shown in plan of assembled gear, and also in the detail drawing. Particular attention of beginners is called to the requirement that all four eccentric-straps and rods ***must be the*** same ***length between centres of straps and eyes*** ; and for their especial benefit I will briefly repeat how to make a simple jig for ensuring this. Get a piece of flat bar say about 3/16 in. by 3/4 in., or larger section, and about 4 in. long. Scribe a line down the middle, and on it make two centre-pops 2-31/32 in. apart. Drill these out with a No. 32 drill, either



Valve-rod

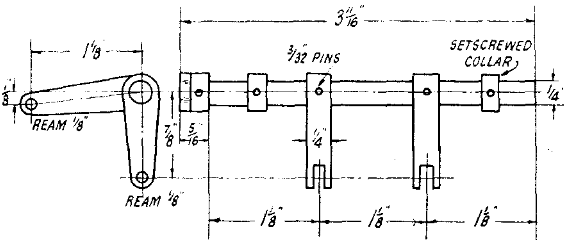
on drilling-machine or lathe ; not by hand, as it is important that they go through dead square. In one of the holes squeeze a short bit of 1/8in. silver-steel ; in the other, a dummy eccentric. Chuck a piece of 1-1/4in. steel rod, and turn down about 1/2 in. of it until one of the eccentric straps fits over it exactly without any shake ; then turn a 1/8in. pip on the end about 1/8 in. long, the pip being an exact fit for the hole in the bar, Part off to leave about 5/16 in. of the 1-1/8 in. diameter beyond the shoulder, and slightly round off the sharp edge ; then press the pip into the bar. You now have a jig consisting of a bar with a pin and a dummy eccentric at exactly the right centres for the finished strap and rod. To use it, put the strap over the dummy eccentric with the rebate in the lug upwards ; put the eye of the rod over the 1/8in. pin, and lay the other end in the rebate in the lug. Solder it in position, with the two parts still on the jig ; then remove it and put the rivets through the lug and the end of the rod. The offset rods are bent before putting them on the jig, and a 1/8in. washer placed over the pin, to line them up correctly with the eccentric-straps. If all four eccentric-straps and rods are assembled on the jig as described, it is impossible for them to be anything else but all alike. The eyes can be case-hardened instead of bushed, as drilling big holes for bushes would weaken them unduly ; but before case-hardening, slightly countersink the eyes in the two offset rods, on the outside of the bend. Beginners again note : to case-harden, simply heat the eyes to bright red, dip in any good case-hardening powder (Kasenit, Ecosite or similar) reheat until the yellow flame dies away, and quench out in clean cold water. Be sure to fill up the eyes when dipping ; after quenching, clean any residue off, and polish up with fine emery-cloth. Lastly, don't forget you want two right-hand and two left-hand rods, one bent and one straight of each kind ; so bear that in mind when milling or filing the rebates in the lugs on the straps. Keep the plan view of the assembled motion in front of you when marking-out the lugs, and there won't be much chance of going astray.



Expansion link

Expansion-Links

Not much chance of going astray here, either, if ordinary care is used. Mark the outline of the links on a piece of 3/16in. ground flat stock, the fine grade of cast steel used for gauge and tool making ; if you can't get any, use ordinary mild-steel. Cut the slots first ; drill a few holes down the marked centre-line, run them into one with a rat-tail file, then open out with a half-round or fishback until a piece of 3/16in. silver-steel can be slid easily, without shake, from top to bottom. A small square file will finish off the ends of the slots. When you get them O.K., saw and file the outline of the links around them ; sounds something like building a barrel around a bunghole, but it is the best way I know, of making links by hand. It isn't worth the trouble of rigging up a special arrangement for milling the slots, when there are only two links to make. A piece of 1/8in. silver-steel is squeezed into a No. 32 hole in the upper lug ; the lower one is drilled No. 44 and tapped 6-B.A., to accommodate a screw which is turned from 1/4in. hexagon steel, to the dimensions given, by the same process used for the hanger screw. The die-blocks are filed up from odd bits of the 3/16in. steel, and should slide from top to bottom of the slots easily, without any shake. Drill them No. 32 and ream 1/8 in If made from gauge steel, harden the links and die-blocks right out. If mild steel, case-harden, as mentioned above. As the pin in the upper lug has to be riveted slightly into the eccentric-rod eye when assembling, it must be softened, and this can be done by holding a red-hot poker against it for a few seconds or so.



Weighbar shaft

Weighbar-Shaft and Lifting-Links

The shaft is a piece of)-in. bright round mild- or silver-steel, 3-11/16 in. long. The two lifting arms are filed or milled up from 3/8in. by 1/4in. mild-steel, to the shape shown; one end is drilled 1/4 in. drive fit, and the other end reamed 1/8 in. This end is also slotted 1/8 in. wide and 5/16 in. deep ; the piece can be held in the slide-rest tool-holder, and fed up to a 1/8in. slotting cutter on a spindle held in chuck or run between centres, or it may be done on a planer or shaper, or by hand filing as preferred. Drive the two arms ***on*** the shaft, as shown, so that their centre lines are 1-1/8 in. apart, and 1-1/8 in. from one end ; make certain that they are quite parallel, which can be done by putting a piece of 1/8in. straight silver-steel through both forked ends at once, and then pin them to the shaft by drilling No. 43 holes. through the lot, and squeezing in bits of 3/32in. silver-steel or 13-gauge spoke-wire. Turn up two little collars 3/16 in. wide, drilled an easy sliding fit on the shaft, and fit them with set-screws. The reverse arm is made exactly as described for the link hangers, but to the dimensions given in the detail drawing ; the boss is drilled 1/4 in. drive fit, and the small end reamed 1/8 in.Don't fix it to the shaft yet.

The two lifting-links are simply pieces of 1/8in. by 1/4in. flat steel rod, drilled No. 32 at 1-3/4in. centres and reamed 1/8 in. ; the ends are rounded off, and one side is relieved to the depth of 1/32 in., to avoid rubbing on the eye of the forward gear eccentric-rod, see end view of assembled motion.

How to Erect the Gear

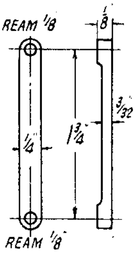
Put the eye of the fore-gear eccentric-rod over the pin in the upper lug of the expansion-link, and rivet over the end just enough to prevent the eye coming off, but not enough to prevent free movement of the eye on the pin. There should be only the merest fraction of end play. File the pin flush with the eye. Attach a lifting link, and the back-gear eccentric-rod, to the bottom lug of the link by the hexagon-headed bolt made specially for the job as above. When screwed right home, eye and end of lifting-link should both be free, but with only the slight end-play mentioned. Give the projecting end of the screw a gentle tap or two, so that there *will* be no chance of it slacking off when " Juliet " gathers up her skirt and runs. Next, put a die-block on the square-headed pin which fits in the bottom of the link hanger ; poke it through the expansion-link, fitting the die-block in the slot of same. Put on one end of the valve-rod, screw the pin through the link hanger, takmg care that the head will be parallel to the link slot when erected, and put on a nut at the back to lock it. Put the fulcrum-pin in the top of the hanger, set the whole bag of tricks between the frames, poke the fulcrum-pin through the 5/32-in. hole in frame, and put the nut on. The eccentric-straps can then be placed on the sheaves, and the screws put in ; the other end of the valve-rod is placed between the jaws of the valve fork or crosshead, and the bolt put through.

Put the two collars on the weigh-shaft. close to the lifting-arms, and then the-two bearings, flanges inward. Put the longer end through one of the 3/8in. holes in the frame ; doesn't matter which, you can have the engine right or left-hand drive as preferred. G.W.R. are right. the others left ; the Brighton engines were "driver-on-the-left," I prefer that side, as it was better for most of the platforms and signals. Set the shaft horizontally, and run it back until the short end enters the other hole ; then run the two bearings up to the frame. enter the bosses in the 3/8in. holes, and screw the flanges to the frame, as shown in the plan view. Set the shaft so that the two lifting-arms are central, then run the little collars back against the bearing flanges and tighten the set-screws ; or you can pin the collars to the shaft if vou so desire. Put the upper ends of the lifting-links in the slots of the lifting-arms, and secure with bolts made from pieces of'1/8in. silver-steel shouldered down at each end and nutted, as described previouslv. Put the reverse arm, boss inwards, on the projecting end of the weighbar-shaft ; set it so that it is vertical when the die-blocks are in the middle of the links, pin it to the shaft, same way as the lifting-arms, and Bob's your uncle.

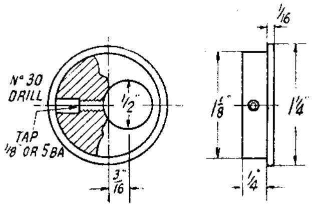
How to Set the Valves

If you want " Juliet " to Pull and Go, in the manger usually -observed among real. " Live Steamers," set your valves like this : Take the steam chest covers off; push the reverse-arm forward, so that the die-blocks are opposite the fore-gear eccentric-rods, and turn the wheels by hand. Adjust valve on spindle so that the port openings at both ends of the movement, are equal. Now put the crank on front dead centre, and adjust the eccentric so that the port is just " cracking," showing as a visible black line at the edge of the valve. Tighten the set-screw and go around to back dead centre. If you get the same crack, the setting is O.K. If no crack shows, the valve is too long ; take a shade off ***both ends*** and try again. Then pull the reverse-arm back, so that-the die-block is opposite the back gear eccentric rod, and adjust the eccentric same as before, so that you get the crack on both front and back dead centres of the crank. When you get a crack on each dead centre, both in forward and back gear, the setting is O.K. The amount of lead increases as a link motion is notched up ; and believe me or not. just as you like, you need plenty when a little: wheeled engine travels at high speed, and the coupling-rods fade out of the picture, otherwise you lose power. Any unprejudiced person can easily see that to get full pressure on the oiston heads as the crank passes-dead centre, you have to open the ports BEFORE the crank gets to dead centre ; and that is one reason why Curly's engines do the doings in the manner once deemed " impossible." The faster the engine goes, the sooner the ports should open, just-the

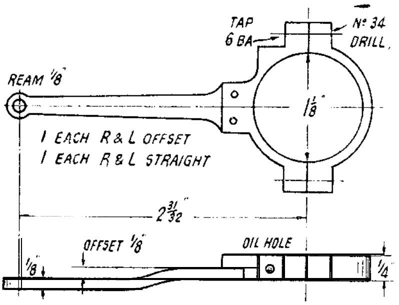
(Continued on page 309)



Lifting link



Eccentric



Eccentric strap and ***rod***

placed close to the smokebox on the right-hand side, whilst the small ejector also functioned as a blower. The larger brass whistle was a good-looking affair with a bell, 4-3/4 by 3-5/8 in. diameter (still largely in use on the L.M.S., by the way) and its companion was a tiny little fellow, only 3-1/4 by 1-1/2 in., but which squealed right lustily when anyone in distress pulled the communication cord ! Two Gresham injectors on the firebox front were very accessible, as were the two convenient toolboxes. The regulator handle was a long 18-in. one, elegant in shape, and the firedoor was given louvres, so angled that when shut not a trace of glare was present, and when opened only a slight reflection from the fire was thrown downwards on to the floor.

Glitter work

There was a fair amount of glitter-work about the engine, for in addition to the two whistles, the casings of the safety valve springs and the rims of the 14-in. cab windows, there were the 6-1/2in. brass numerals (perhaps the tallest in use at that period), the z-in. polished rim round the big splasher, the truly wonderful driving wheel axlebox with its four attendant lubricators, together with the polished brass handles and lens-rims of the headlamps, and the polished steel top plates of the two rear, and six tender, axleboxes !

It is difficult to give an adequate impression of the degree of finish of the exhibition engine. But this is how it was obtained, and after reading the account of what happened in the Derby beauty-parlour, perhaps a dim idea of her mirror-like surfaces may come to the mind. Here goes. First a coat of priming before steam trials. These over, all rust and scale was removed and two coats of lead-coloured paint were applied. After thoroughly drying, all defective surfaces were stopped or filled up with a mixture of gold size and dry white lead. These were then rubbed down with pumice and water to a perfectly smooth finish. Next came no fewer than four coats of purple or chocolate, and lastly one of a mixture of crimson lake and purple brown to give the famous Midland dark red tint. Lining with black edging and its thin yellow stripe followed, and the black work of platforms, brake gear, etc., was finished. And now, patiently, one after the other, came five coats of best varnish ! No wonder it took six days to get over all this ! The engine proudly left the paint shop in all its glory, though personally, I always thought that six months' wear was needed before perfection was obtained. In that time all steel handles and brass work got that lovely glow that comes from repeated friction from men's hands, or from rag and metal polish. The lining scheme was simple-just a small black border with an inner single fine yellow line next the red.

This'was placed on cab side-sheets and front sheet, round the windows, at the base of dome, lagging belts, driving splasher, round edge of red mainframe standing above footulate under the smokebox, along outside frames and steps, round the red guardirons, round the red sandboxes, driving horns, and round the other eight axleboxes. Tyres black with one yellow line, bogie hubs red with two yellow circles, and little vees top and bottom of spokes.

The buffer beam and buffer sockets were vermilion, edged black, with fine white line (the buffer sockets having this edging at the outer end only). Gilt letters with blue shading adorned the buffer beam and tender side. The latter had two black rectangular bands with a yellow stripe on either side, and its red coping was also lined with a yellow stripe. The outside springs of the engine were dark red with a yellow stripe along the top and bottom leaf. The interior of the cab was light grain edged with a broad black band separated from the grain by a fine white line. In addition to these three wonderful exhibition engines,Nos. 1853, 189 and 240, the L.N.W.R. sent a fine model of one of their compounds, Dreadnought; whilst the North London Railway contributed a superb 1/8scale model of one of their 4-4-o tank engines. Yes, there were models as well as the " real thing " to delight the eyes of the visitors to that truly wonderful exhibition of 1889!

Useful Dimensions

Length of buffers I ft. 5-1/2 in. Leading overhang 2 ft. 3in.

Bogie wheelbase 6 ft. o in. Bogie to driving axle 7 ft. 0-1/2 in. Driving axle to trailing axle 8 ft. 9in. Trailing overhang 3 ft. 8 in.

Diameter of wheels 3 ft. 6 in., 7 ft. 6 in., and 4ft. 2-1/2 in.

Boiler 4ft. 7in. (lagging) by 10-ft. 4in. Firebox 6 ft. 6 in. long. Driving axle to firebox front 1 ft. 9 in.

Link Motion for " Juliet"

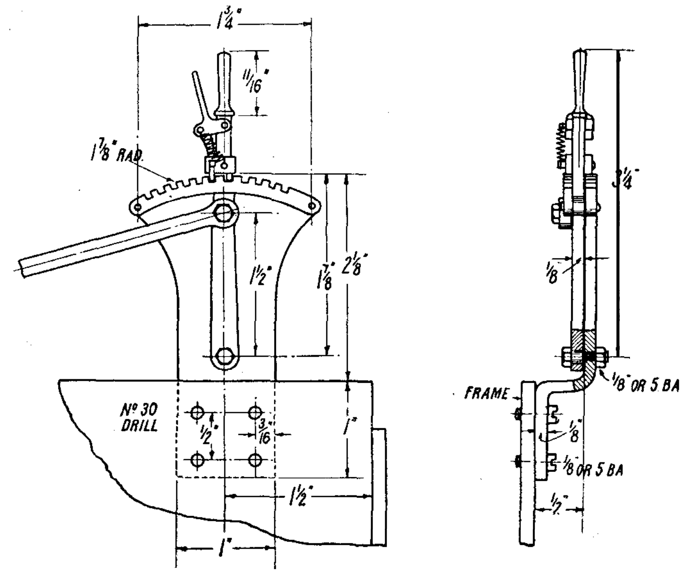
(Continued from page **304)**

same as advancing the ignition in the cylinders of an automobile " exceeding the limit."

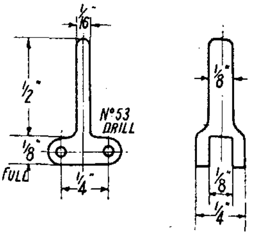
Valves can also be set under pressure, by disconnecting the big or little end of the connecting-rod, applying air pressure to the steam-chests by a tyre-pump, and turning the wheels by hand. The piston-rods should shoot in and out vigorously, at the exact instant the cranks reach the front and back dead centres. I usually set my own engines' valves under pressure, as I find it saves time, especially in the case of piston-valves. Well, so much for that ; all we now need, is a reversing-lever for the driver, and that will be the next item.

" L.B.S.C." DESCRIBES THE REVERSE LEVER FOR
“ JULIET ”

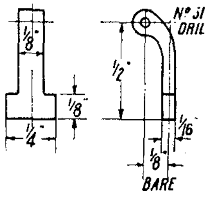
ABOUT the handiest form of reversing gear for a small tank engine like “Juliet,” is the plain “ pole ” lever ; and here, as promised, is a short illustrated description of a suitable gadget. Castings may be available for the stand, and may save a little sawing and filing ; but one can be bent up easily enough from a piece of 1/8in. steel, measuring approximately 3-3/4in. by 2 in. An odd bit of frame steel will do fine. Scribe a line down the middle? then set your dividers to 1-7/8 in. between points, and strike off an arc across one end, with one divider point on the centre line ; then mark the piece of steel to the outline shown, and saw and file to shape. Beginners note, don’t cut any notches in the curved edge yet ; leave it plain. Mark off two lines at I in. and 1-1/2 in. from the bottom edge, and bend the. stand to two right-angles, as shown in the cross-section and end-view ; ***the*** offset should be exactly 1/2 in., but you needn’t bother about “ mike measurements,” as the lever has only to be set out sufficiently to clear the ***boiler.***



Reverse lever for "Juliet "



Trigger



Latch

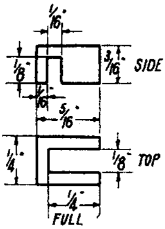
The retaining-plate, or sector-plate, is a curved strip of steel 3/16 in. wide, same radius as the top of the stand. It may be bent up from a piece of 3/16in. by 1/16in. strip steel, if you are any good at what my young niece in her schoolgirl days called “ bendification ” ; or it may be marked out, and sawn and filed, from a piece of 16-gauge sheet steel. Incidentally, several old readers of these notes want to know what happened to the before-mentioned niece ; well, she just followed the usual feminine ” profession “got married just before the war, and now has two fine “ ***O*** gaugers,” the elder of the two finding his greates happiness beside the local railway line. I haven’t seen him yet, as they live far beyond visiting distance ; but he knows all about my railway and locomotives, and I guess we are both looking forward to a meeting in the not-too-distant future !

The sector-plate and stand are kept at the right distance apart, by two spacers, made by chucking a piece of 3/16in. round steel rod in three-jaw, facing, centring, drilling down about 3/8 in. with No. 51 drill, and parting off two slices a full 1/8 in. in thickness. Drill a No. 51 hole at each end of the sector plate, then clamp it to the stand, and use for a jig to drill similar holes in the top of the stand. Put a spacer between sector-plate and stand at each end, and rivet the lot together by a couple of 1/16in. iron or brass rivets. Drill four holes with No. 30 drill in the bottom extension of the stand, at the points shown in the illustrations ; drill a ***No. 40*** hole on the centre line, 1-7/8 in. from the top, and tap it 1/8 in. or 5-B.A. for the fulcrum pin of the lever, and job No. 1 is done.

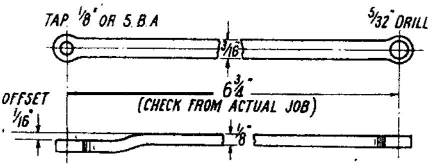
Lever

The lever can be milled, or sawn, filed, and turned, from a piece of 1/4in. square steel rod ; or you can build it up, the latter being by far the easier for a beginner. In the former case, you need a piece of rod 3-1/2 in. long. Chuck truly in four-jaw, and turn the handle (but not like an organ-grinder turns one I) to the shape shown, or to your pet fancy. Then reduce the rest to 1/8 in. in thickness by milling or filing 1/16 in. off each side, and finally taper the lever as shown. To build up, saw off a piece of 1/8in. by 1/4in. mild-steel 2-5/8 in. long ; file it taper, and round off the full-sized end. Turn up the handle from a piece of 3/16in. round mild-steel held in the three-jaw and either braze or silver-solder it to the top of the flat part of the lever. I usually build up my levers, using a spot of Sifbronxe to stick the bits together ; with " white " Sifbronze, the joint is practically invisible. Right at the bottom of the lever, drill a 5/32in. hole ; at 1-1/2 in. above it, drill a No. 40 hole and tap it 1/8in. or 5 B.A. for the reach rod pin.

The trigger is milled, or sawn and filed, from a piece of 3/8in. by 1/4in. mild-steel a full 5/8 in. long. Mark off the outline as shown, on one of the wide sides, then centre-pop and drill the two No. 53 holes clean through the block. For beginners' benefit I will repeat that when holes are required dead in line through a valve-gear fork, or anything with a similar gap between, such as this trigger, the best method of ensuring that they ***will*** be in line, is to drill a continuous hole clean through ***before slotting.*** If drilled after slotting, in 99 cases out of 100, the drill point will " wander " when it meets the other side of the gap, and the holes won't line up for toffee-apples. Next cut the 1/8in. slot right across the bottom of the block. If you have a regular 1/8in. milling cutter, mount it on a spindle between centres, clamp the block in a small machine-vice on the saddle, at a height sufficient for the cutter to take out the full depth at one " bite " ; and using medium speed and plenty of cutting oil, you'll get a perfect slot. Another way is to clamp the piece on its side, under the lathe tool holder, at centre height, and traverse it across an end-mill or home-made slot drill (I prefer the latter, it cuts faster) held in the three-jaw. I have described several times, how to make these slot drills. The upper sides of the block are then milled, or sawn and filed away, ***to*** leave a tongue 1/16 in. in thickness, which forms the trigger part. Note, after the lower ends have been rounded off, the slot should be open, top and bottom, right to the trigger.



Latch-block



Reach-rod

The latch is a tricky little doings, but can be cut from a piece of 1/4in. square steel about 5/8 in. long, either by milling, or by saw, file, patience, and perseverance.

If a milling machine is available, mill away the two sides first, with a side and face cutter, then the surplus metal under the " bird's head," and finish off with a file, drilling the hole last of all. For hand work, follow the same " ritual," except that saw and file take the place of the milling cutter. The bird's head should fit nicely between the jaws of the trigger.

To make the latch block, a piece of 1/4in. by 3/16in. steel is needed, 5/16 in. long. This merely requires cross-slotting, either by milling, as described above, or by judicious use of a thin flat file, such as used by key-cutters for forming the wards in keys. The 1/8in. slot should be a close fit on the lever ; and the narrow slot should just be wide enough to let the cross-piece at the bottom of the latch, slip up and down easily.

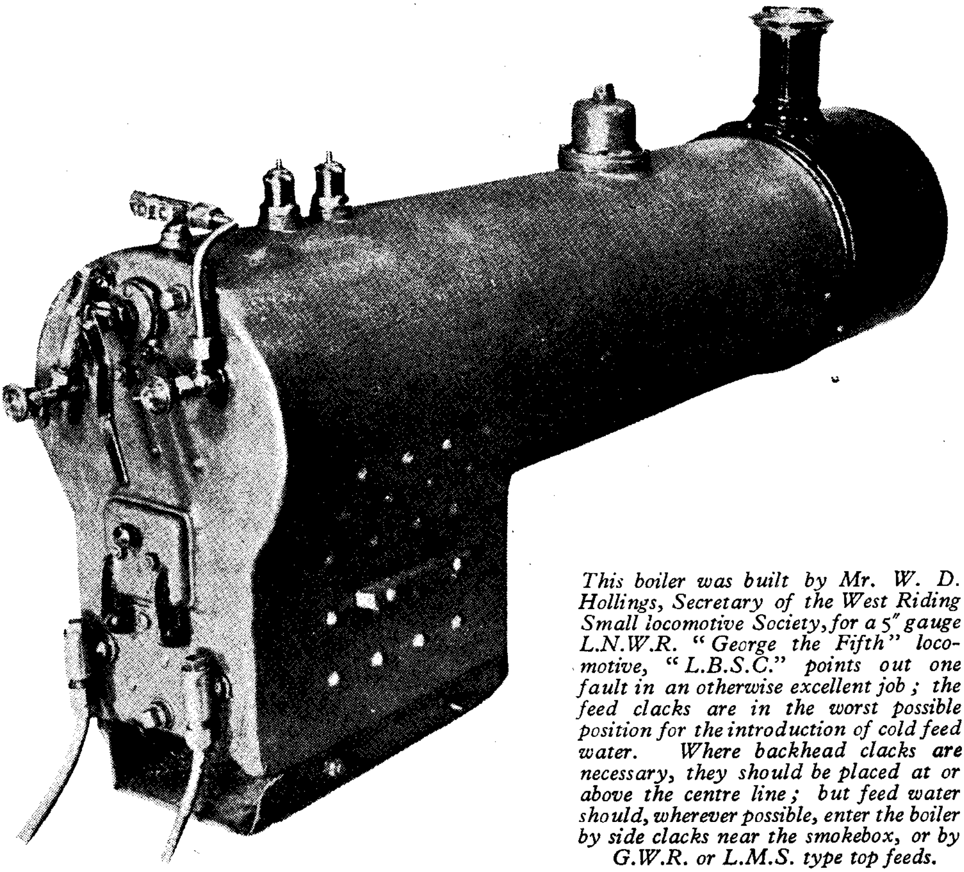
How to Assemble

Put the trigger in the position shown, just underneath the handle of the lever, and put a No. 53 drill through the lever, using the hole in the trigger as guide. Remove trigger, and open out the hole in the lever with No. 51 drill ; then replace trigger, and drive a bit of 1/16in. silver steel wire through the lot, filing flush each side. Put the bird's head of the latch in the slot at the other end of the trigger and pin it in similar manner ; but instead of filing both sides flush, leave enough of the pin sticking out, to enable a weeny spring to be looped over the end. Now put the latch block in position, adjusting it so that when the trigger is squeezed against the handle of the lever, the cross-piece at the bottom of the latch is flush with the bottom of the block ; but don't pin it to the lever yet.

Now we need a fulcrum pin for the lever. Chuck a piece of 3/16in. hexagon steel in the three-jaw ;if you haven't any, use 1/4in. round. Turn down a full 3/8in. length to an easy fit in the hole in the bottom of the lever ; then further reduce 1/4in. length to 1/8in. diameter, and screw 1/8 in. or 5 B.A. to match the hole in the stand. Part off to leave a 1/8in. head ; if round stuff has been used, slot it with a hacksaw. Put the lever in position between the sector plate and stand, screw the fulcrum-pin through the hole in the bottom, into the stand, and put a lock-nut on, outside the stand. When the fulcrum-pin is screwed right home, the lever should be just free to move, without any sideplay.

The latch block should just clear the curved top of stand and sector-plate ; if it is too far away, make the necessary adjustment, and then drill a No. 53 hole clean through block and lever. Drive a 1/16in. pin through the lot, leaving enough projecting on the left side, to take the other end of the before-mentioned weeny spring.

To find the position of the notches, put the lever forward as far as it will go, mark the spot exactly under the latch, and file a little square-ended nick at that point, about 1/16 in. deep, and just wide enough to take the latch without letting it rattle. Now pull the lever right back, and repeat operation ; then put the lever in the middle, and file another notch. That gives you full forward and full back gear positions, and mid gear. The other notches are merely " rule-of-thumb " ; just file them with a 1/16in. gap between, putting in four between mid and full gear each side of centre, and taking your measurements from full gear position. More notches and finer adjustment can, of course, be obtained by using a thinner latch, narrower notches, and less space between them, but I don't recommend it. Writing about these levers always reminds me of a trip on an old Kitson 0-6-0, with a broken coil balance-spring on the weighbar shaft. I kidded myself I was strong enough to notch her up with steam on, but the blessed lever got away from me just outside Norwood Junction, broke all the fore gear notches except one, and hit the end of the quadrant with a fearful crash that roused the echoes. Luckily nothing happened underneath, but the amount of coal we used finishing the journey in full gear wouldn't have pleased Mr. Shinwell a little bit !



This boiler was built by Mr. W. D. Hollings, Secretary of the West Riding Small locomotive Society, for a 5″ gauge L.N.W.R. " George the Fifth" locomotive, " L.B.S.C." points out one fault in an otherwise excellent job ; the feed clacks are in the worst possible position for the introduction of cold feed water. Where backhead clacks are necessary, they should be placed at or above the centre line ; but feed water should, wherever possible, enter the boiler by side clacks near the smokebox, or by G.W.R. or L.M.S. type top feeds.

All the goods drivers used to carry a wooden wedge to stick in between the latch and notches, to stop the lever from rattling, otherwise the din was absolutely awful when the engine began to get a move on. Happy days !

How to Erect the Lever

Set the lever assembly with the step in the stand level with the top of frames, as shown in the end view, and the centre line of the stand 1-1/2 in. from the back of frame (see side view). Clamp temporarily in place, using toolmaker's cramp or any other means available ; run the No. 30 drill in the holes at the bottom of stand, making countersinks on frame ; follow up with No. 40, tap 1/8in. or 5-B.A., and put in-screws to match. Alternatively, run the No. 30 drill clean through frame, and use bolts instead of screws. :

The reach-rod for connecting the lever to the arm on the weiahbar shaft is made from a niece of 1/4in. by 1/8in. mild-steel a little over 7 in. long As it is hidden from sight for most of its length, there is no particular need to reduce the centre part to 3/16 in. width unless you desire it ; a plain rod with rounded ends. drilled as shown. would answer just as well. However, one end needs to be offset, as indicated in the detail sketch, to make a proper connection between reach-rod and reverse-arm. The cab end of the reach-rod is attached to the lever by a similar pin to the fulcrum-pin, except that the screwed part is only 1/8 in. long, threaded to match the hole in the lever. When screwed right home, the eye of the reach-rod should have just the weeniest bit of side-play, not enough to rattle. The other end of the rod is attached to the reverse arm by a 1/8in. or 5-B.A. screw having a full 1/8in. of plain part under the head, so that when it is screwed through the hole in the reverse arm, into the reach rod, the joint should be perfectly free when the screw is in tightly. " Juliet " will be able to turn her little wheels pretty quickly, and shake the valve-gear up to some purpose, so all builders should make absolutely certain that there are no screws, or bolts, or anything else in the valve-gear, left slack enough to stand the slightest chance of working loose. Final tip for beginners : don't take the given measurement for the reach-rod, between centres of holes, as " absolute gospel " in case of any error in setting out and erecting either weigh bar shaft, arms, or lever. Put the lever in mid position, and the valve-gear ditto ; that is, with the die-blocks in the middle of the links. Then measure the distance between the centre of the hole in the reverse arm, and the centre of the tapped hole for the reach-rod pin, in the lever ; that will be the exact length of the reach-rod between centres, *after* setting same over as shown.

All that remains, it to connect the projecting pins in the trigger and latch block, by a similar spring to those on the mechanical lubricator pawls. When the lever is in the full forward and backward notches, the corresponding eccentric rods should be opposite the die blocks in the links, and the valves will cut steam off at about 3/4in. stroke. Beginners should remember that because an engine has a valve-gear that enables an early cut-off to be used, it doesn't follow that an early cut-off should be used ***all the time.*** Also, if you try to start an automobile engine by hand, with the ignition fully advanced, you stand a chance of getting a sprained wrist, if nothing worse ; and starting a link-motion locomotive with the lever next to middle, is a steam equivalent. My recommended valve settings give the correct amount of lead (corresponding to correct ignition point) for a quick smooth start in full gear, and just as you advance the car engine's ignition as the speed increases, notching up a link motion opens the ports earlier as the wheels turn faster, and thus maintains full pressure on the piston heads as the cranks pass the dead centres, with the added advantage of closing the steam ports early, economising steam, and opening the exhaust ports early, avoiding back pressure.

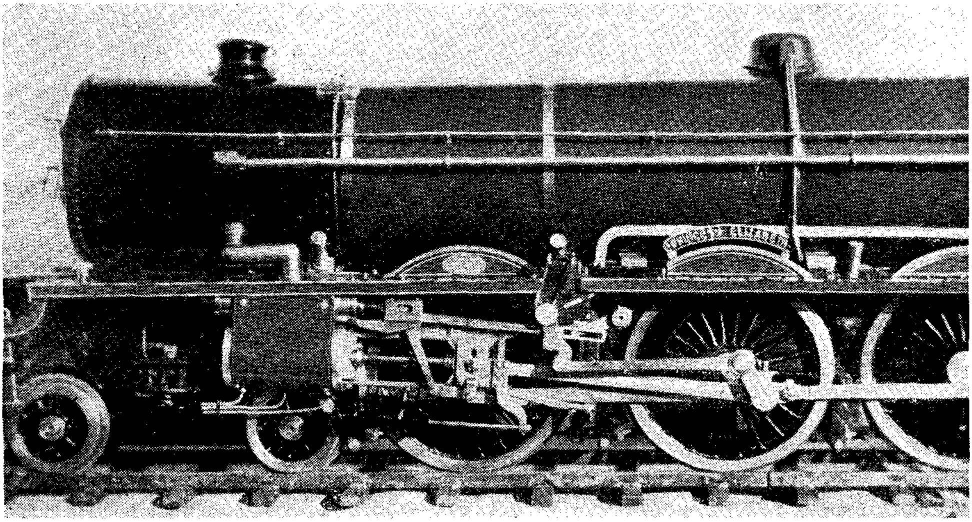
How a " Chatterbox " Was Cured

Some little time ago, I gave an account of how a new tail bearing was fitted to the mandrel of my Milnes "Type R " lathe, and said the information might be interesting to other lathe users. It certainly was ! The following extract from a correspondent's letter is worth putting on record ; I cannot do better than quote the actual written words. My correspondent writes :

" I wish to thank you sincerely for solving for me a problem which has been nattering at me for the last ten years. What a chump, you will say, for taking ten years over the solution ! Well, perhaps so, but this was the way of it. Ten years ago I bought a new 5-in. lathe of well-known make, thinking that if I sprang the cash for a new lathe which had not been mucked about by some other twerp, I should be sitting pretty. But was I-heck ! It would neither turn nor bore parallel, and parting-off was just too bluepencil.

" I temporarily rectified the lathe sufficiently to construct my first locomotive, afterwards stripping it right down, and rebuilding it very carefully, bedding down all sides to a surface-plate ; also having the mandrel ground up dead true all over, and the spindle bearings lined with

(Continued on next page)



The " works " of Mr. Hollings's L.M.S. 4-6-2 " Princess Elizabeth "

BUOYANCY — By R. F. Wilson

MODEL marine work when completed looks and is beautiful, looks but is not difficult. looks but is not expensive ; in fact, size for size, it is one of the cheapest forms of model engineering.

if a beginner should be contemplating building a working model, it is essential that he should understand that this is a branch of model engineering where, if the first and vital principle is wrong, no amount of juggling with weights will put a model dead right. This being so, it is as well to point out that the fundamental basis of a working model, as against an exhibition model, is buoyancy, and without going into the theory of this subject, it can best be demonstrated by saying that if you have two hollow hulls of the same material and of identical outside form, but with different thickness of hull walls, the one with the thinnest wall would have the highest buoyancy factor.

The reason why ‘the buoyancy factor is so important is because it is this which governs the total weight the hull can carry and at what height from the bottom of the hull, without wallowing like a duck ashore, or turning right over.

It is known that a hollowed-out wooden hull, can be made quite quickly until the final stages of thinness are reached, when the greatest care, and, naturally, the longest time must be taken. The writer has found from his own models that it is quicker in the end not to hollow out the hull, but by using it as a former, form a light metal hull round it, so that when the wooden hull is removed there is left a metal hull of the highest buoyancy factor into which can be placed the power plant, and on which can be built the superstructure. Unless the superstructure has been made from solids, the model will need lead ballast placed along the bottom inside the hull to bring her down to her designed water-line, without need for that monstrosity, the false keel.

It is best to install the boiler so that its top is either below, or in line with the designed water-line. not above it : because. although we know that a large boiler means long runs between refills, it is rather absurd to have to reduce visual deck details just to carry a lot of extra water in a massive boiler carefully hidden below decks, when model is floating in that same water, which, with just a little exercise can be transferred from outside the hull into the inside of a boiler of a size the completed model can carry.

We also know that the strongest container for the petrol required for the blowlamp is a circular tube with end plates brazed on ; but it has been found that with the pressure as used by the “ Prototype ” men, it is quite safe to use a flattened oval tank with cross stays to the end plates. This type of tank not only reduces the. height of the weight of the petrol and container above the bottom of the ship, but also reduces the height of the weight of the valves, filler cap and outlet pipe as well.

This “ height of the weight above the bottom ” is important, because cases have been known where a beginner has completed a working model ship only to find that, although she floats along the designed water-line as long as his hand keeps her upright, she develops a decided list one way or the other as soon as his hand is removed. This puzzled the builder until it was pointed out that, although the total weight was correct, far too much of it was high up from the bottom, and the writer explained matters in this way : somewhere inside the hull there is a point which the weight above this point uses as a fulcrum to lever the weight below it upwards, and hence causes that list. When this is understood, it becomes obvious that the higher a weight is above that point, the less will be the weight required to produce the same degree of list, which is the reason why we try to get the greatest amount of weight inside the hull to lie along the bottom and as close to the centre line as possible.

“ L.B.S.C.” *(Continued from previous page)*

white metal and rebored a close fit for the mandrel. There were numerous other little improvements : but when everything was re-assembled, I found that the parting-off was no better than before, so I just used to set my teeth, whilst the spanners bounced about on the lathe bed and usually finished up on the floor ! Then Hitler started his games, so the problem was shelved for several years, during which period I acquired a I in. to 2 in. mike, in addition to my 0 in. to I in. ditto.

“ A few months ago I read your account of the new outer bearing you fitted, after 23-1/2 years, to your Milnes lathe when chatter began to appear in turning. I jumped out of my armchair with a yell of ‘ Curly has hit it,’ to the great alarm of my good lady, and rushed out through a snowstorm to my garden workshop, where in about half-an-hour I dismantled my headstock for about the umpteenth time, pulled the outer bush out of the casting (with a pair of pliers-‘nuff sed !) and got to work with my 2-in. mike. In a few minutes the trouble was laid bare. There was not only 0.001 in. play between the bush end and the mandrel, but the bush was 0.002 in. slack in the headstock casting.

“ I acquired a nice length of phosphor-bronze, and took it, plus the old parts, around to an obliging friend who kindly promised to do the needful. He has just become the proud owner of a practically new 4-1/2in. South Bend lathe, which is a lovely machine, and made short work of the new bush. I drew it in carefully with a long bolt and a couple of plates, re-assembled the rest of the head-stock parts, tried my broadest parting tool on a bit of mild-steel, and it went through like a knife slicing butter. The problem was solved at last, and thank you, Curly, you old trouble-shooter ! ”

Comment is needless ; as my correspondent himself remarked, “ ‘nuff sed ! ”

“ L.B.S.C.”

THE BOILER FOR “JULIET”

ALTHOUGH the boiler for the little four-wheeler isn’t such an elaborate box of tricks as that for the “ Lassie,:’ and only a fraction of the size, it will prove just as efficient in steam production. My three-cylinder compound “ Jeanie Deans ” has a boiler with a barrel which is exactly similar, and contains the same number of tubes arranged in exactly the same way; the only difference in the firebox is, that it is a little deeper, as there are no eccentrics or other impedimenta under it. This boiler provides all the steam needed, with a blast about as strong as the cough of an asthmatic black-beetle-the initial pressure in the L.P. cylinder seldom exceeds 15 lb. per sq. in., so you don’t need telling what the exhaust pressure is !-and it doesn’t need a Sherlock Holmes to deduce that the lively exhaust from “ Juliet’s ” cylinders when those little wheels are spinning merrily, will keep the home fires burning, and the gauge needle well up to blowing-off point. My L.B. & S.C.R. engine “ Grosvenor,” which is now well on the way, is being furnished with a similar boiler, the difference in this case being merely that the grate slopes from back to front, as on big sister ;and I am anticipating plenty of white feathers showing above the spring-balance safety valves on top of the dome.

To save unnecessary queries, if anybody wants to use a bigger boiler with a wide firebox (some folk prefer the “ Bill Massive ” variety) or to fit an oil-fired water-tube boiler, I will be only too pleased to give the necessary variations, as it is my earnest desire to please as many as possible. Builders preferring the last-named, need not wait for a separate drawing to appear, but can get busy making up a shell as described below for the loco-type boiler, using 18 gauge steel, and either riveting or brazing-up the throatplate as desired.

Barrel and Wrapper

In view of the continued shortage of copper tube-one of our advertisers told me he has just received delivery of boiler tubes ordered from a firm specialising in copper tubes, in January, 1946 !-I have included a sketch showing a complete barrel and wrapper in the flat. To make this you will need a piece of 16-gauge sheet-copper measuring 11-3/8in. by 12-1/4in. At 4-3/4in. from one of the shorter ends, each side, make a snip 2-1/8in. long;then from there to the end, take off a 1/16in. strip each side. Now bend the whole issue into a circle 3-1/2 in. outside diameter ; this allows a 1/4in. overlap on the barrel part.

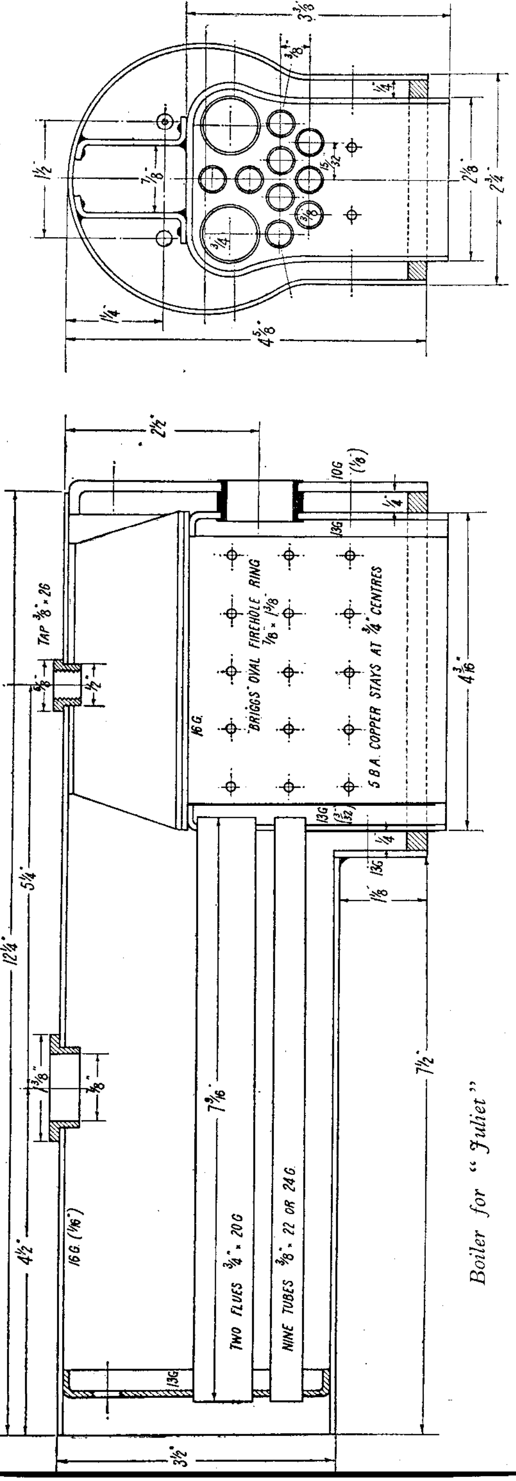
Young Curly used to bend boiler barrels around stone ginger-beer bottles (he respected his mother’s rolling-pin), bits of rainwater pipe, or anything else that happened to be somewhere near right size. Tip to beginners : soften the copper sheet before attempting to bend it. Put a few 3/32in. copper rivets through the overlap; then open out the 4-3/4in. portion each side, to the shape of the firebox, as shown in the cross-section of the boiler. I made “ Grosvenor’s ” boiler shell in an exactly similar manner, and it came out O.K. Provided that you use something as near the proper internal diameter (3-3/8 in. as possible, you shouldn’t have any difficulty in getting the barrel nicely rounded.

If a piece of 3-1/2in. by 16-gauge seamless copper tube is available, it can be used. Square off the ends to a length of 7-1/2in. ; then bend up the wrapper from a piece of 16-gauge sheet copper, 11-3/8in. long by 4-3/4in. wide.Attach it to the barrel by a 1/2in. butt-strip extending three-quarters around the barrel, the job being carried out as described for the joint between barrel and wrapper on the “ Lassie.” Look that up, and you’ll be saving me a lot of unnecessary repetition. Some folk will doubtless say, why not use a piece of 3-1/2 in. diameter tube squared off to a length of 12-1/4 in and split and open out 4-3/4 in. of it to form the firebox wrapper ? Well, you can if you like ; but you’ll find that the wrapper will be 1/4 in. shallower at the bottom, consequently giving either less depth of firebox, or if the firebox is made to given dimensions, the foundation ring will be higher up, leaving 1/2 in. of the bottom exposed instead of 1/4in., and sacrificing heating surface in the most valuable place.

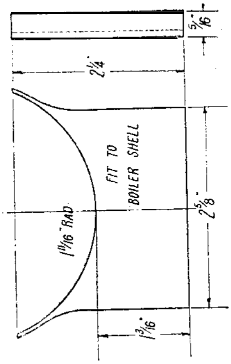
Former and Throatplate

The backhead former will be needed for flanging the throatplate, so cut this out of 1/4in. steel or iron plate, to dimensions shown in the illustration. This isn’t such a formidable job as it sounds ; use a drop of cutting-oil on the saw, which should have 18 or 22 teeth per inch? bear down hard on the forward stroke, operating at about 60 per minute, and you’ll find the blade will just walk easily through the plate. Finish with a file, and round off one edge.

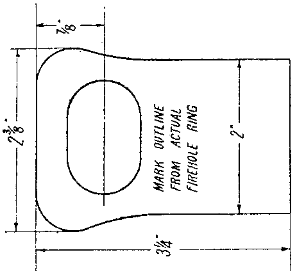
Cut the throatplate from 3/32in. or 13-gauge copper, to the shape shown in the illustration, but allow 1/4 in. extra each side for flanging. The radius at the top can be made either by drilling a series of holes, breaking out the piece and filing to outline, or sawing it with a metal-piercing saw. I do mine on the “ Driver ” jig-saw, which takes only a few minutes-time is precious now! A spot of cutting-oil or a smear of beeswax helps the saw to cut easily and clean. Grip the plate and the former together in the bench vice, the plate being level with the bottom of the former, and beat down the edges to form flanges, as described for “ Lassie,” “ Petrolea ” and other engines. Anneal the copper at once, if it shows any sign of going hard, and starts to buckle ; but such short flanges usually give no trouble of that sort. Clean up the flanges with a coarse-cut file ; also clean the edges of the firebox wrapper where they will come in contact with the throatplate flanges, and the adjacent edge of the barrel.



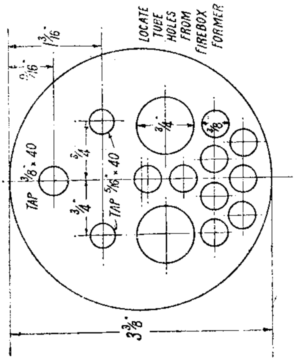
Boiler for "Juliet"



Throat-plate



Firebox door-plate



Smokebox tube-plate

Insert the throat plate in position, with the metal immediately below the radius, butting up tightly against the edge of the barrel ; hold temporarily in place with a toolmakers' cramp at each bottom corner, then put about three 3/32in. copper rivets each side, to hold the wrapper in close contact with the flanges whilst brazing in the throatplate.

"The Tools for the Job "

As it is not so long since I described how to braze in the throatplate on the " Lassie's " boiler, there is no need to set out the complete ritual again ; beginners and inexperienced workers who need full instructions. can refer to those notes. which also specified "the tools for the job." Briefly, stand the boiler, barrel upwards, in the brazing-pan, piling coke all around to the level of the throatplate, and putting some inside the shell. Anoint the joints with some flux mixed to a paste with water <Boron compo is as good as anything, for use with ordinary brazing strip) and after heating up all the whole lot as a preliminary, concentrate on one bottom corner of the throatplate, applying the strip of brazing metal when the copper reaches bright-red. Then move the flame very slowly along, feeding in more brazing strip as the copper heats up to bright-red ; and work your way up to the barrel, then around the joint, between barrel and throatplate, letting the brazing metal melt and form a fillet from one side of the throatplate to the other. Then go either up or down the other side, as you fancy. Take care to run in plenty of brazing metal at the end of each " crack," where the wrapper merges into the circular shape.

If the barrel and wrapper are separate, made from tube and sheet, with a butt-strip inside, beginners and inexperienced workers are advised to run in a little coarse-grade silver-solder before applying the brazing-strip. The reason is, that this material " sweats " in easier than the strip, and is more likely to make a perfect joint. A good wheeze, and one which is essential if the joint is made with " Sifbronxe," using an oxy-acetylene blowpipe, is to file a V right around, and fill it up with the brazing material. The boiler should be laid first on one side, then stood right way up, then laid on the other side, to go right around the joint in the proper manner. Beginners again note ; never mind if you get a little too much brazing material on the job ; it can always be filed off. Better be on the safe side than risk a crop of Welsh vegetables ! Let the iob cool to black before putting it in the acid pickle, then wash off in running water, and clean up with a handful of steel-wool.

Firebox

The firebox former, which also serves as a tube-drilling jig, is cut from 1/4in. plate as before. Set out the location of all the tube holes as shown, and drill a No. 40 hole at each point. Lay the former on a piece of 13-gauge sheet copper, and scribe a line all around, 1/4 in. from edge, except at bottom. Repeat operation for firebox door plate. Cut out the pieces, and flange them over the former as previously described. Before removing the first one from the former, run the No. 40 drill through all the holes, going right through the copper. After removing from former, and filing up the ragged edges, run a 23/64in. drill through all the holes for small tubes, and 47/64in. for the flues, following up with 3/8in. and 3/4in. parallel reamers, respectively. Countersink the holes slightly on the side opposite flange. The door-plate is, of course, not drilled ; merely file off the ragged edges. Clean up all the flanges with a coarse-cut file.

The firehole ring is made the same way as " Lassie's," from a piece of 1-3/8in. by 1/8in. copper tube squared off to 5/8in. length.. Turn down 3/16 in. of each end to a bare 1-1/4in. diameter, leaving 1/4 in. full diameter in the middle : anneal. and squeeze oval in bench vice so that the hole is approximately 7/8in. by 1-3/8in. Lay the oval ring on the firebox doorplate with the centre 7/8 in. from the top ; scribe a line all around it, cut out the piece, clean ring and plate, poke the lip of the ring through the hole. from the side opposite fange, and beat it outward and down until tight.

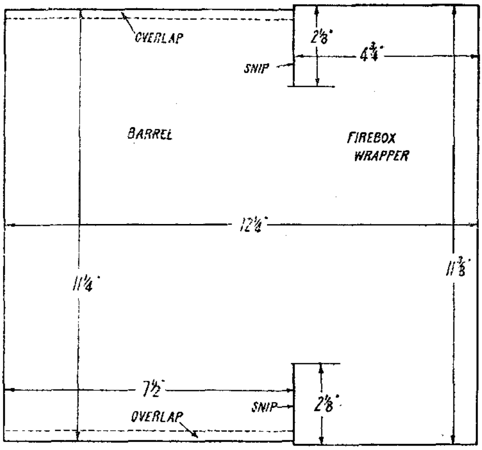
A piece of 16-gauge sheet copper 9 in. by 4-3/16 in. is needed for the sides and crown of the firebox. This is annealed and bent to the shape shown in the cross-section of boiler. using the end-mates as guides. The flanges of the end-plates are cleaned up with a coarse file, also the edges of the firebox side and crown, and the ends are then riveted in with a few 3/32in. copper rivets. Only enough are needed to hold the parts together whilst brazing ; they take no part at all in helping the boiler to resist pressure, the brazing taking care of that part of the business.

Girder Crown-Stays

The two girder crown-stays are made from 16-gauge copper,, 4-3/16in. long at bottom, 3-1/4in. at top, the upper flanges being 1/4in. wide, and the lower 3/8 in. wide. They are riveted to the crown of the firebox at 7/16 in. each side of the centre-line, half-a-dozen rivets in each being plenty. In these days of shortage, I use all sorts of scrap sheet for things like girder flanges ; used and discarded photograph printing blocks, for example. Those I, used were 16-gauge copper of excellent quality. The firebox and crown-stay assembly can then be brazed up, using the same " technique " as for the throatplate. When you come to the crown-stay girders; stand the firebox right way up, and run a good hefty fillet of brazing material alone the inner side of each girder, opposite to the flange. Certain " die-hards " are still moaning about the liability of these girders to tear away from the firebox crown ; all I can say is, that if one did, the firebox crown would come with it ! How do I know-why, bless your hearts and souls, I've tested one to complete destruction. It isn't any game of Curly's to dole out a lot of untried ideas, or " paper designs," and leave unfortunate builders to find out if they are O.K. or otherwise, maybe at some risk to themselves. I build locomotives, and put them on the track instead of on paper only ; readers of these notes get the benefit of my experience.

Smokebox Tubeplate and Tubes

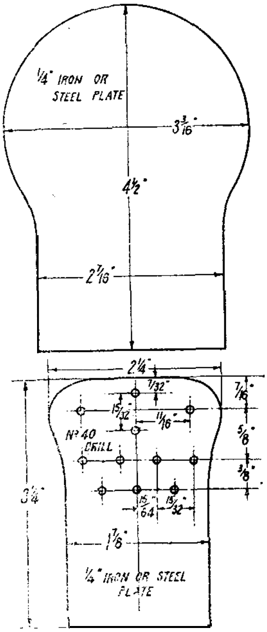
The former for the smokebox tubeplate can be anything circular and of the right diameter ; I use old wheels, chuck-plate castings or anything else that may be handy. The required diameter for “ Juliet’s ” boiler is 3) in., and one edge should be rounded off, same as in the case of the shaped formers. Cut out a circle of 3/32in. sheet copper 3-7/8 in. diameter, anneal it, and flange it over the former as previously described. Chuck in the three-jaw, flange outwards, and skim off any raggedness ; then reverse and re-chuck on the outside of the top step of the outside jaws, gripping by the inside of the flange. Turn down the flange until the tubeplate is a tight fit in the boiler barrel. In passing, several correspondents who are building the “ Lassie ” complained that I gave the wrong size for the formers, saying that they should have been the size of barrel, wrapper, etc., inside, less two thicknesses of the metal. Not at all ; I gave dimensions for the formers, that ensured plates fitting correctly. For example, according to these correspondents, the diameter of the former for “ Juliet’s ” smokebox tubeplate, should have been 3-3/16 in., allowing for two thicknesses of metal, which would have brought the diameter of the plate nominally to 3-3/8 in., the internal diameter of the boiler barrel. Sounds all right, but ignoring the fact that the metal becomes thinner when hammered down to form the flange, there wouldn’t have been anything left to take off by turning ! The finished diameter of a 3/32in. plate flanged over a 3-1/4in. former, is approximately 3-13/32 in., which allows for taking a skim off the flange in order that it may fit the end of the barrel in the proper manner.



Barrel and wrapper “in ***the flat”***

The setting-out, drilling and tapping of the steam-pipe and stay-holes in the smokebox tubeplate, are shown in the accompanying illustration. To locate the tube-holes, simply clamp the firebox former to the tubeplate with one or two toolmakers’ cramps, the centre of the middle hole in the bottom row being approximately 3/8 in. above the flange. Put the drill through the lot, then open out and ream exactly as you did those on the firebox tubeplate.

Two pieces of 3/4in. by 20-gauge seamless copper tube, and nine pieces of 3/8in. by 22- or 24-gauge ditto, are the next requirements ; cut ***them*** full length, and skim off the ends in the lathe until the overall length is 7-9/16 in. Clean the ends with rough emery-cloth, clean the tube holes in the firebox tubeplate, and insert the tubes, letting them project a bare 1/16 in. into the firebox, and putting the smokebox tubeplate on the other end, to act as a steady and a spacer. Line up the whole nest parallel to firebox sides, and square with the tubeplate ; they can then be silver-soldered in, exactly as described for the “ Lassie.” Experienced coppersmiths can do the lot at one fell swoop ; beginners are advised to insert the two flues and the two small tubes between them first, and silver-solder them. The rest can then be inserted and silver-soldered as a separate operation. If 24-gauge tubes are used, don’t use an oxy-acetylene blowpipe to do the silver-soldering, as tubes of this thin gauge, whilst quite able to stand the working pressure (thinner tubes on Sir Hiram Maxim’s first steam aeroplane, built when I was a kiddy, stood 500 lb. per sq. in. easily) are very easily burnt. As one of the old comic songs says, “ It’s done before you know where you are ! ” Personally, I prefer the big diffused flame of an oxy-coal-gas blowpipe, or a paraffin blowlamp, for silver-soldering boiler tubes. Anyway, whether you put them in at one shot, or by two bites, take off the smokebox tubeplate and heat the outer ends to dull red, before putting the job in the pickle. I guess that will be enough to keep builders busy for a week or so, so we’ll leave the assembly till the next instalment.



Formers for throat-plate, backhead and firebox

“ JULIET ”

Boiler Assembly, First Stage

Fitting the firebox and tubes into the shell of “Juliet’s” boiler is an easier proposition than doing it on the “ Lassie,” but the modus ***operandi*** is very much the same ; and if you have read the “ Lassie ” notes, there isn’t much to add. However, whereas the “ Lassies’ ” front firebox plate butted up to the throat-plate direct, on “ Juliet’s ” boiler we have to insert the front section of the foundation ring, as the firebox tubeplate butts up against it, and is held to it by three rivets through the lot. Cut a piece of 1/4in. square copper rod approximately 2-5/8 in. long, and fit it tightly between the flanges at the bottom of the throat-plate ; and beginners especially, don’t forget to clean the bit of rod with a file, also the metal it comes in contact with, so that the brazing material will “ take,” and the ring be free from leakage.

Lay the boiler-shell upside down on the bench, and slide the firebox-and-tube assembly into it, letting the firebox tubeplate butt up against the bit of foundation-ring just put in. Adjust the firebox so that the distance between it and the shell is the same at each side ; then put a couple of toolmaker’s cramps over the lot-throat-plate, piece of rod, and tubeplate-screwing them tightly so that nothing can shift. Then see if the top flanges of the crown-stays are making full-length contact with the wrapper. If not, make the necessary adjustment until they are ; then put a clamp on the end of each, to hold it to the shell. Next, put in a few 3/32-in. round-head copper rivets to hold the parts whilst brazing ; three will be enough to hold the firebox, rod, and throat-plate together, and four through each crown-stay flange and the wrapper. Use No. 41 drill. I described how to rivet the crown-stay flanges when describing “ Lassie’s ” boiler ; briefly, after drilling the holes and scraping off burrs, insert rivets with a notched strip of metal, and rest the head on a bar sticking sideways out of the vice jaws whilst you assault the stem outside the wrapper with the ball end of the hammer-head. Beginners take care to hit the rivet and not the wrapper ; and you needn’t be particular about making the heads look pretty, as they can be filed flush after the crown-stays are silver-soldered to the wrapper, their period of usefulness then being over. The silver-soldering provides all the strength needed.

Now insert the smokebox tubeplate, flange first and vertical, so that the tube holes lie in horizontal rows. Carefully drive it in until it is almost touching the tubes, then line these up with their holes, by aid of a piece of round wood ; a skewer, pencil, or knitting-needle does well. Drive the tubeplate down a little farther until all the tubes project about 1/32 in. The tube ends are then expanded into the holes by driving a taper drift into each ; this is just a tapered piece of metal like a drill shank, perfectly smooth. Grease it before inserting into each tube ; give it three or four cracks with a hammer, and the job is done. It should come out quite easily with a pull; if not, hit it gently sideways, or prod it out with a rod through the tube.

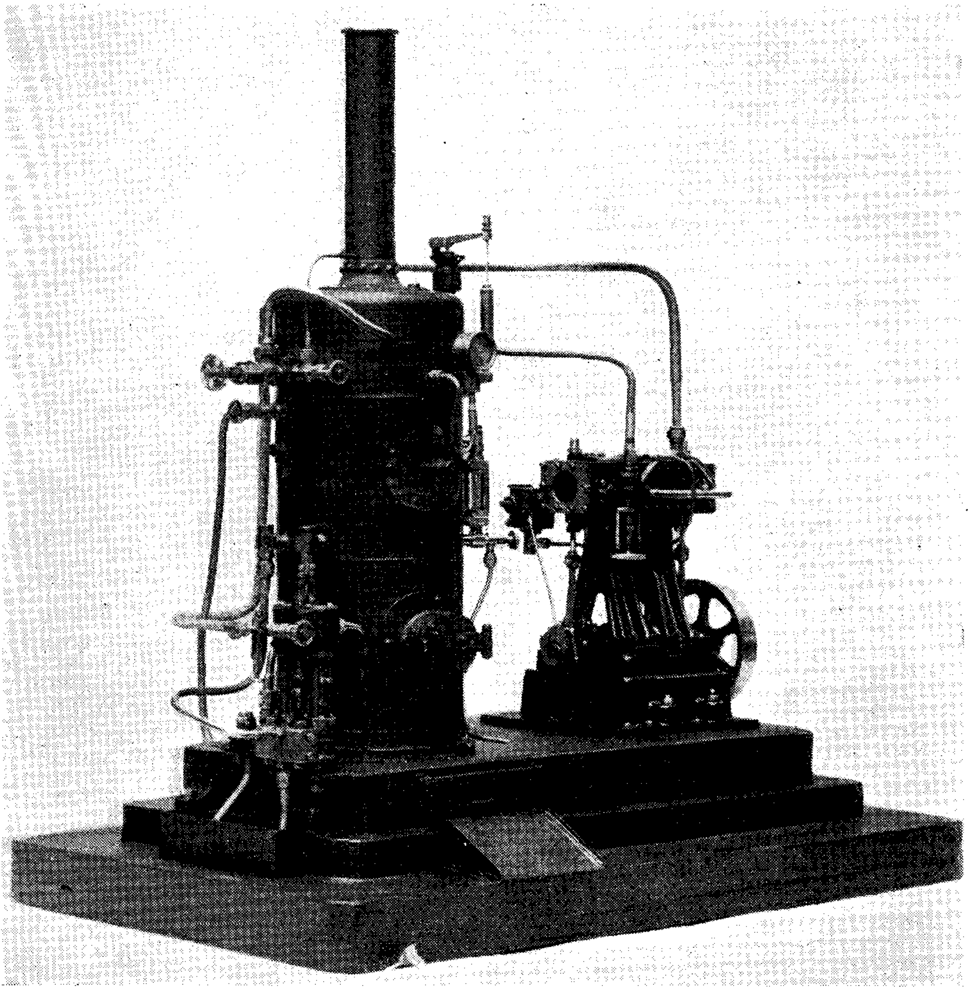
An Easy Brazing Job

The operation of brazing in the smokebox tubeplate, and silver-soldering the tubes and crown-stay flanges, was described in some detail quite recently for the “ Lassie’s ” boiler, and even more fully for “ Petrolea ”; so I need not elaborate again here. Briefly, put some wet flux around the edge of the smokebox tubeplate, around the tubes, and along the crown-stay flanges. Plug the tube ends with wads of asbestos string or flock. Stand the boiler, barrel upwards, in the brazing-pan, and put a lid or tray with a hole in it, over the barrel; about 3 in. or so down, propping it in position by aid of bricks or anything else handy. Pile coke around to level of end of barrel ; heat up the whole boiler end, then concentrate on one point of the circumference, apply the brazing-strip, and work your way right around, as described for the throat-plate joints. Beginners, don’t forget that the metal of the barrel and tubeplate must be hot enough to melt the brazing-strip, otherwise you will get a leaky and defective joint. Small pieces of silver-solder can be dropped among the tube ends, and the whole lot done at once by directing a big flame over them ; or you can blow on two or three at a time, and apply your silver-solder in a strip. if the tube ends are hot enough, the end of the strip will melt, and the liquid metal will “ flash ” around each tube, making a neat and perfect seal.

When the smokebox end is done, whip off the tray quickly, so as to prevent the boiler cooling off, and lay the latter on its back in the pan, with the firebox overhanging. By blowing the flame first inside, and then underneath, direct on the wrapper opposite the crown-stay flanges, it is possible to heat up the lot to medium red, at which temperature a strip of good-grade silver-solder will melt and “ sweat ” completely through the joints between flanges and wrapper. It is a good plan to lay a strip of silver-solder along each side of each crown-stay flange, covering them with flux ; and then all you have to do, is to apply the heat treatment inside and out, until the flux fuses, the silver-solder melts, and finally disappears into the joints. If you are lucky enough to possess two blow-lamps, use one (the smaller) to blow inside ***on*** the flanges, and the other to blow outside on the wrapper ; the job can then be done very quickly. Let it cool to black before putting it in the pickle, and mind the splashes ; the boiler will hold a considerable amount of “therms ” even when black-hot, as it now has plenty of metal in it.

Back-head and Foundation Ring

Cut out a piece of 1/8in. sheet copper about 5/16 in. larger than the back-head former, all around except at bottom, and flange it over the former as previously described, cleaning the flanges with a file. Measure distance from top and sides of wrapper, to firehole ring ; transfer measurements to the back-head, and mark the outline of the fire-hole ring in the position indicated. Cut out the piece, either by drilling holes all around inside line, breaking the piece out, and filing to shape, or “ fret-sawing ” it out with a metal-piercing saw. Place back-head in position, with the lip of fire-hole ring sticking



Locomotive blobs and gadgets on Mr. P. J. James's stationary engine

through the hole, and beat down the lip over the back-head, outwards, so that the plate is gripped tightly between the beaten-down lip and the shoulder. The ring can be supported by a bar of iron projecting sideways from the vice-jaws, while the operation is in progress. If the wrapper isn't in close contact with the back-head flange all around, teach it manners with a mallet or soft hammer. I use a hide-faced *hammer for* jobs like these.

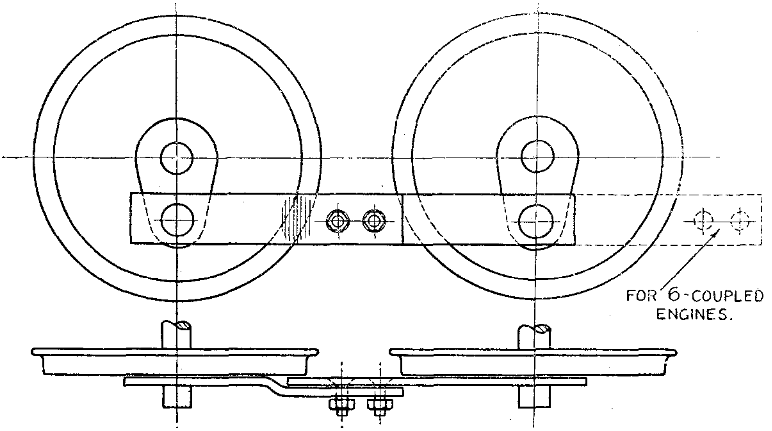
The spaces at the sides and rear end of firebox, between it and the wrapper and back-head, are now filled up with pieces of 1/4in. copper rod, cleaned with a file, and inserted so that the edge of the wrapper is about 1/16 in. proud of them, this leaves something against which the brazing material can run and form a fillet. Hold them in position with a tool-maker's cramp at each end, and drill No. **41** holes at about 5/8 in. centres through the lot, securing with 3/32-in. copper rivets as mentioned for the front section between firebox and throat-plate. If there should be interstices at the ends, where the four sections of the ring meet, plug them with splinters of copper, driven in flush. If you haven't already drilled the holes *on* top of the *barrel for* the dome and safety-valve bushes, do it now (I usually do this job when first making the boiler-shell) then turn up the bushes as shown on the longitu*dinal* section, and fit them. They should be a good tight fit in the holes. Warning to beginners : never make bushes of brass, always use good gunmetal or bronze, either drawn or cast. Personally, I prefer copper, and always use copper bushes when material suitable for making them is available. The dome bushes for " Jeanie Deans " and " Grosvenor " were turned out of pieces sawn from a copper plate 3/8 in. thick, the square being held in the four-jaw whilst the hole

(Continued on next page)

PRECISION WORK ON COUPLING-RODS

by T. RICHWOOD

THE following method was employed to locate my coupling-rod centres accurately and easily and will ensure that any other " first timer " in the small locomotive world may do likewise. The engine is an 0-4-0 industrial tank, 5 in. gauge and was started when Mr. Cos suggested it via " L.B.S.C." in **THE MODEL ENGINEER.** The wheel centres are 7 in. so, of course, the coupling-rod centres must be the same. When the wheel centres were checked with a height vernier they were found to be 6.994 in. and 6.995 in. so 0.006 had been lost in marking out the frames etc. The problem was now, how to drill the rods. Although the centres could be marked accurately enough using the vernier, a lot can happen between " popping " the intersection of two lines and drilling a hole. There was a good method described two or three years ago in **THE MODEL ENGINEER** using a dial indicator and toolmaker's buttons but these were not available, and in any case this method is quicker. The crankpins are 7/16 in. diameter and although it is known that a running clearance is necessary to allow the wheels to " ride " to the road, the clearance is lost if it is used to correct inaccuracies in the centres. Two pieces of steel 1 in. X1/8 in. x 6 in. were cut and a 1/8 in. joggle made in one at about 1-1/2 in. from one end so that when one piece is laid on the other as in the sketch the ends are in the same plane. At about 1-1/2 in. from the end of each piece a 7/16 in. hole was drilled and reamed. The chassis was stood on temporary rails with each crankpin on the centre and the pieces of steel fitted on to each pin. The pieces of steel were lined up, cramped together and drilled with two 3/16 in. holes at about 3/4 in. centres. The pieces were taken off and the outer piece of steel opened out to 1/4 in. diameter and the inner piece countersunk on the inner side. Two 3/16 in. diameter countersunk bolts and nuts were used to fasten the pieces together. They were only " nipped " up and not tightened. The jig was placed on the crankpins again and the chassis rolled up and down the piece of track until, by adjusting the jig centres, no hard spots were felt. Then the nuts were tightened up and the jig removed. Two drill bushes were made of silver steel 7/16 in. outside diameter and 1/4 in. bore. They were not hardened as they were not required to drill more than two holes each. With the drill bushes in position and the jig clamped to the rod the holes were drilled 1/4 in. diameter. The jig was removed and the holes opened out in easy stages to 7/16 in. and the rod tried on the chassis. The final size was 9/16 in. to accommodate the gunmetal bushes but to check the method the rod was tried whilst there was still time to correct if things had gone wrong. The jig worked perfectly, however.



" L.B.S.C."

(Continued from previous page)

was drilled ; then the piece was chucked by the hole, and the outside turned to shape. When the bushes are fitted to the barrel-none are needed in the back-head-the boiler is then ready for the final brazing job.

Another Use for Blobs and Gadgets

'Tisn't only locomotive builders who find these notes useful ! The engine shown in the reproduced photograph is the handiwork of Mr. P. J. James, of Worcester, who incorporated in it all the principles expounded in the " gospel of live steam," and added some locomotive fitments which can be clearly seen in the picture, namely, duplex donkey-pump of the type with central trip-rods, injector, and mechanical lubricator. Our worthy friend says they all give complete satisfaction, and do not look out of place, adding to the efficiency of the engine, which is a good worker.

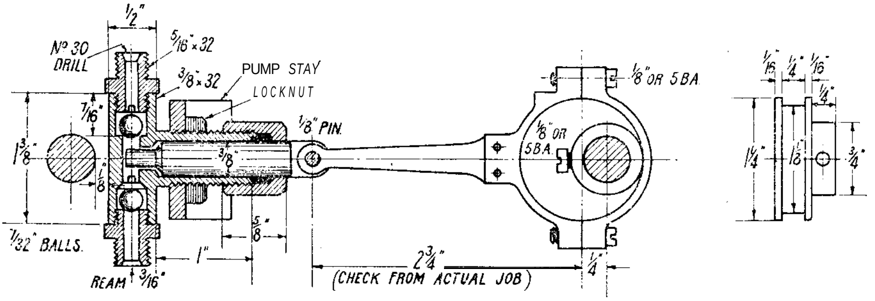
" L.B.S.C." DESCRIBES THE BOILER FEED PUMP FOR
" JULIET "

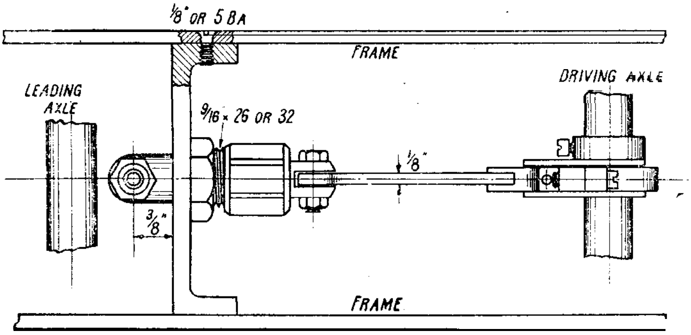
SOME new readers of this journal who have started to build " Juliet," have raised a bit of a moan because I referred back to the notes on the smaller boiler feed pump for the " Lassie " for details, illustration, and general instructions on making up a similar gadget for the little tank engine. They say they are completely stuck because they can't get hold of the necessary back number, and our " Production editor " suggests that I should " come to the aid of the party " in a manner of speaking, by giving a separate drawing and a few notes on the missing link. All sereny, anything to oblige ; I freely admit the grievance is perfectly legitimate, but at the time I referred back, the issue concerned was still obtainable, and, in fact, many builders who fell in love with " Juliet " when that young lady first made her debut, had the back number handy, and so had no trouble in making the pump. Well, here's all the doings in brief.

The cross-stay carrying the pump is a casting which can be supplied by Simmonds, Haselgrove, or any other advertiser supplying " Juliet " castings and material. The only machining it needs, is facing off the two side flanges, and drilling and tapping the hole for the pump barrel. The former job can be done in the lathe, by clamping the casting under the slide-rest tool-holder, and traversing it across an endmill about 3/4 in. diameter held in the three-jaw. You can set the casting square by putting on the faceplate, and running the slide-rest up to it, setting the flange on the casting to touch the faceplate full length, then tightening the clamp. Careful hand filing, checked with a try-square, will also do the trick. As for the hole, that is drilled plumb in the middle of the casting. Drill a 1/8in. or 3/16in. hole first, as a pilot ; then follow up with 33/64in. drill, and tap 9/16 in. by 26 or 32.

Pump-barrel and Valve-box

Chuck the casting by holding one end of valve-box in three-jaw, and set the other end to run truly. Face, centre, drill right through with No. 14 drill, open out and bottom to 7/16 in. depth with 11/32-in drill and D-bit, and tap 3/8 in. by 32, taking care not to let the tap scrape the seating. Countersink the hole very slightly and skim off any burr. Reverse and re-chuck on a stub mandrel held in three-jaw ; this is a bit of brass rod 1/2 in. diameter or so, with the end turned down for about 3/16 in. to 3/8 in. diameter,





Details of pump for " Juliet "

and screwed 3/8 in. by 32. Repeat operations as on other end, except that the D-bit isn't needed.

Next, chuck by the piece provided, opposite the barrel, and set the barrel to run truly. Face, centre, and drill 7/32 in. until the drill breaks into the passage-way, in middle of valve-box, then open out to I in. depth with 3/8 in. drill. Turn down the outside to 9/16 in. diameter, and screw 9/16 in. by 26 or 32. Face off the end, so that the barrel is I in. long. Finally poke a 3/16 in. reamer through the hole in middle of valve-box.

Seat a 7/32in. rustless steel ball on the D-bitted seating, and take distance from ball to top of box with a depth gauge. Chuck a bit of 1/2in. hexagon brass rod, and turn down to 3/8 in. diameter, a length 1/32 in. less than the distance just mentioned above. Screw 3/8in. by 32, and part off 5/8 in. from the end. Reverse in chuck, turn down 1/4in. length to 5/16 in. diameter, screw 5/16 in. by 32, centre deeply, and drill right through with No. 30 drill. Cross-nick the end, so that the ball does not block the passage-way when it rises. Repeat operations for the lower chamber of the valve-box, but this time turn the end of the cap to the same length as distance from ball to end of valve-box. Drill the cap No. 14, and ream 3/16 in. Face the end, removing 1/32 in. of metal, and seat the ball on the end of the cap, cross-nicking the hole in the valve-box with a little chisel, home-made from a bit of 3/16 in. round silver-steel. If the caps are then screwed in tightly, as shown in the section, no jointing material need be put on the threads, as the faced shoulders of the caps should seat steam- and water-tight against the faced ends of the valve-box. I have known of several pump failures caused by beginners allowing jointing material to get on the ball seats and prevent the balls closing the passages completely, so that water just " see-sawed " back and forth in the pump.

Screw the barrel of the pump through the hole in the stay, and put a lock-nut on ; making that from7/8in. round or hexagon rod is a very easy job which needs no detailing. Have the pump valve-box at right-angles to the stay, and parallel with the side flanges ; although it will work even if erected all cock-eyed, it doesn't look so well !

Ram and Gland

The pump ram is a 2-1/8in. length of 3/8in. round rustless steel, bronze, or gunmetal rod. It should need no turning to fit the pump-barrel, but the end is reduced to form an anti-airlock pin (Curly's " patent ! ") which makes certain that the pump always delivers full measure, and does away with any need for an air chamber. Chuck in three-jaw, and turn down 5/16 in. length to 3/16 in. diameter, bevelling off the shoulder to the same angle as the point of the drill used for the barrel ; see longitudinal section. Drill a cross-hole 3/16 in. from the other end, with No. 32 drill, and ream it 1/8 in. ; then round off the end, and slot it 1/8 in. wide and about 7/16 in. deep, by the method I have so often described for valve-gear forks and such like jobs.

Although I have shown the gland made from round material 3/4 in. diameter, with longitudinal slots in it for operation by C-spanner, there isn't the slightest objection to anybody making it from hexagon rod if they so desire. It is made exactly as described in my instructions to beginners for making union nuts, except that it is drilled 3/8 in., opened out with 33/64-in. and tapped 9/16in. by 26 or 32 to match the pump barrel.

Eccentric, Strap and Rod

These are made as described for the valve-gear components of similar pattern, so only brief mention will be needed. The eccentric, or "tumbling block " as the old enginemen termed it, is turned from a bit of 1-1/4in. steel shafting held in three-jaw, the groove being formed with a parting tool. Part off at 5/8 in. from the end. The tool marks will indicate the true centre ; at 1/4 in. away, make a centre-pop, and then chuck in four-jaw with the pop mark running truly. Drill first 1/8in. or No. 30, open out with 31/64 in and ream 1/2 in Mount on a bit of round rod, and chuck in three-jaw with the groove nearest chuck ; then turn the boss to 3/4 in. diameter and 1/4 in. wide. Drill it No. 40 and tap 1/8 in. or 5-B.A. for a set-screw.

The strap is cleaned up with a file, the lugs centre-popped and drilled No. 40. Saw across, using vice jaws to guide the saw. Tap the holes in the lug half 1/8in. or 5-B.A., and open out the holes in the other half with No. 30 drill. Smooth off saw marks, join halves together with screws, chuck in four-jaw with hole running as true as you can get it (it will now be oval) and bore out to fit nicely on the eccentric. Face one side whilst still chucked, and mount on a stub mandrel to face the other side.

Slot the lug either by milling or filing, and fit a steel eccentric-rod 1/8 in. in thickness, to shape shown, but don't drill the hole in the end, nor file the eye to shape, until after the pump has been erected. The exact length of the eccentric-rod should always be ascertained from the actual job, so as to get the right clearance between ram and end of barrel.

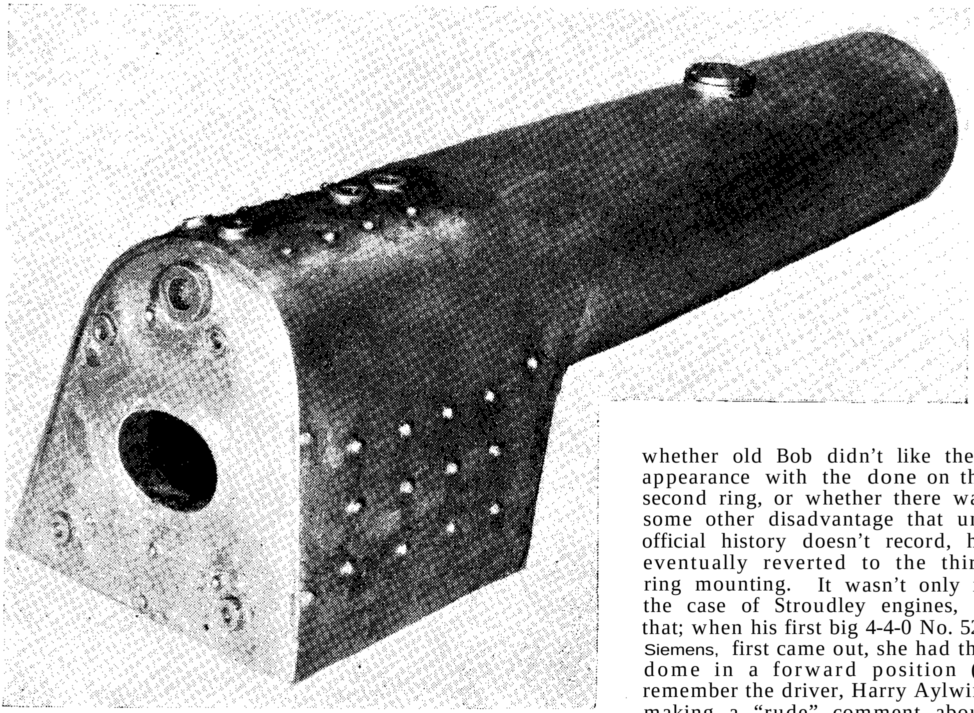
Erection

This is an easy job. Just set the pump-stay level with bottom of frames, with the valve-box vertical, and 1/8 in. behind the leading axle. Run the No. 30 drill through the holes in frame, making countersinks on the pump-stay flanges, follow up with No. 40, going right through, tap 1/8in. or 5-B.A., and put in countersunk screws to match. Push the pump ram back in the barrel as far as it wil! go, place end of eccentric-rod in slot, and with a bent scriber, mark the position of the cross-hole in ram, on the end of the eccentric-rod. Remove rod, make a centre-pop 1/32 in. nearer the strap, than indicated by the scriber mark. Drill the hole No 32 and ream 1/8in., then file the outside of the eye to shape around the hole. You can case-harden it if you like, as described for valve-gear and other eyes, or drill the hole 3/16 in. and fit a little 1/8in. bronze bush.Make a wrist-pin or gudgeon-pin from a bit of 1/8in. round silver-steel, reduced at both ends to 3/32 in., screwed, and furnished with nuts ; pack the gland with a few strands of graphited yarn, or a bit of unravelled hydraulic pump packing (this is not graphited, but impregnated with a special lubricant) screwing the gland up just tight enough to prevent leakage, but not tight enough to bind on the ram.

Different Folk, Different Fancies

A quibble was recently raised in the correspondence columns about the position of the dome on the Stroudley engines of the L.B. & S.C. Ry., the writer of the letter stating that, *in his opinion*, they were set too far back. Well, to anybody familiar with the construction of the engines, the question of the dome position is one that answers itself, in a manner of speaking, as the Cockney boy realised when he said to his new girl friend, " What's your moniker ? " and she replied with a smile, " Monica Watts." The barrels of the Stroudley boilers were made in three rings, and the dome was set on the third ring. Had it been mounted on the second ring, the complaint would probably have been that it was too far forward ; whilst had it been placed in what the writer of the letter apparently considered the correct position, it would have come slap on the circumferential lap joint between the second and third rings, and I can hardly imagine the immortal Billy emulating Muggins of that ilk, and pulling a boner of that description!

As a matter of fact, when Bob Billinton first started reboilering the " D " and " E " class tanks, he actually did mount the dome on the second ring, putting the whistle on a manhole cover over the firebox wrapper ; but I never heard any of the enginemen, nor in fact anyone else, express the opinion that the appearance of the engines was thereby improved. Their working certainly wasn't, for the new boilers, being injector-fed with cold water, instead of hot water pumped in, burned more coal, and our pockets suffered accordingly. Anyway, whether old Bob didn't like their appearance with the done on the second ring, or whether there was some other disadvantage that unofficial history doesn't record, he eventually reverted to the third ring mounting. It wasn't only in the case of Stroudley engines, at that; when his first big 4-4-0 No. 52, Siemens, first came out, she had the dome in a forward position (I remember the driver, Harry Aylwin, making a "rude" comment about it) but the later engines of the same class, built by Sharp Stewart and Co. at "tomato" price per lb.-it worked out exactly at me current price of tomatoes at the time the engines were built !-had the dome set farther back. This was also the case with the big radial tanks ; see illustration of 405, *Fernhurst*, on page 364 of Dendy Marshall's *History of the Southern Railway. Incidentally*, this picture gives a good idea of how engines were really cleaned in the good old days:



Boiler similar to " Hielan' Lassie's," built by Mr. Calf and brazed by Mr. Hollings

The same correspondent said he considered the Stroudley cabs ugly. Well, " you pays your money and you takes your choice " ; some folk consider the Epstein statues are beautiful and artistic, and your humble servant, plus thousands more, reckon the " M.N.," " W.C.," and " Q1 "classes on the Southern Railway to be the most horrible nightmares that ever set wheels upon rails. A " Johnson " type Midland cab, whatever merits might attach to its outline on a Midland engine, would have looked a bit of a fright on a Brighton engine, and what the drivers and firemen would have said about the short roof, would have raised the steam pressure to blowing-off point without the bother of lighting a fire in the box. However, the significant fact is just this : that when Bob Billinton came from the Midland at Derbv. to take the place of the deceased and ever-lamented Billy, he couldn’t have thought very highly of the Johnson cabs because he promptly perpetuated Billy’s cab, except that the weatherboard had a curved front and ‘a curved roof, instead of Billy’s straight front and dished roof. The reason for this small variation is plain for any unprejudiced person to see, inasmuch as it was a cheaper form of construction. Old Bob was a rum character in many ways, and cantankerous to boot (although, strictly sneaking, it wasn’t Bob himself. but his unfortunate ailment, which was the ‘trouble ; it “ got him ” in the end, alas !) but he deserved the highest credit for sticking to Billy’s colours, and keeping the rule of “ every man to his own engine ” as far as possible. Also the cap badge he designed, was artistic and distinctive ; I still have mine.

Ah well ! forgive a rambling reminiscence ; but if anybody starts shying metaphorical bricks at my dearly-loved darlings-now, alas! no more--I just have to hold forth in their defence. Anyway, the little reincarnation that is coming into being on my bench, will have the dome in the place her big sister carried hers, although I could put it anywhere between cab and chimney, seeing that the boiler is made from a single sheet like “ Juliet’s” Also, she will have a straight-fronted cab with a dished roof; and let me whisper in your ear-that wonderful magician of the pencil, locodelineator F. C. Hambleton, has been kind enough to draw for me, an exact reproduction of big sister’s number plates, so that the plates the little girl will carry on the sides of the before-mentioned cab, will be something that Inspector Meticulous and every relation and friend of his in the whole wide world, won’t be able to find fault with. She will also have working sanding gear ; and with my arrangement of link-motion and valve-setting, she should be able to confound everyone who “ goes by the book,” as far as tractive effort and acceleration are concerned.

An Impromptu M.I.C.

Incidentally, I can clear up one point that has puzzled many students of locomotive lore, and that is, why big Grosvenor was apparently a slower starter than the other engines of class “ G.” The cause was in the valve-setting, which was slightly different from that on the others, and she had 1/8in. inside lap, which is fatal to quick acceleration. To the best of my knowledge and belief, the valve timing was never altered. The best of the “ G” class single-wheelers, for getting away smartly without any sign of a slip, was old Fairlight (Charley Winslett’s engine, No. **331)** and she had r-in. laps and over 1/4 in. of lead. If any “ knowledge-box ” as we used to call them in the locomotive sheds, starts in to dispute that statement, he is speaking out of turn, because I saw it with my own pair of eyes.

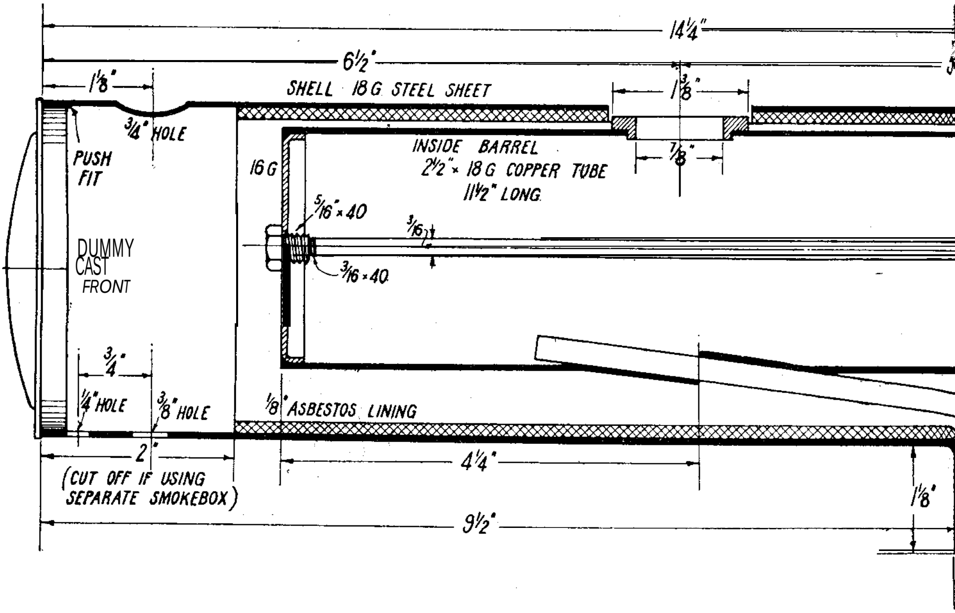
Four young scallywags on duty in the otherwise deserted locomotive shed on a Victorian Sunday afternoon-your humble servant was one of them-found that particular engine with the steam-chest cover off, for the purpose of facing the ports and slide-valves ; and being like the “inquisitive kiddy ” in the old-time music-hall song, “ Of an enquiring turn of mind,” we decided to do a little investigating into the mysteries of valve-setting. With the aid of a pinchbar, a couple of torchlamps, and a pocket mirror. we set to work with all the earnestness and gravity imaginable. Young Curly, naturally, knew the fitting-shop method of getting the exact dead centres, and we found the-marks on the guide bar all right ; by aid of those, and chalk marks we made on the rim of the driving wheel, we got the dead centres “ as near as makes no odds,” as they say in the classics. To our great surprise, when we took a look in the steam-chest to see where the slide-valves were, the port on the dead-centre side was well open, over tin. I thought, maybe, the lever wasn’t in full gear, so one of the boys went up in the cab to investigate, and found that it was. He called out for us to watch the valve whilst he worked the lever (we always called the reverser a “ lever,” whether it was either a “ pole ” or a wheel-and-screw) and we saw the port open a bit more as the links passed mid-position, then come back approximately to the same place in full back gear. This began to get interesting, so we tried all four dead centres and found the leads approximately equal, then measured the valves, and the distance between the outer edges of the ports, and became so engrossed in the job that we never noticed that the “ boss,” who had come in unexpectedly for some reason unknown to us, was coming down the shed !

He naturally wanted to know what the blue-pencil we were up to, so we just said we had finished our cleaning, and finding the engine with the steam chest cover off, were trying to learn a bit about the valve movements. instead of “ flying off the deep end,” as would probably be the case at the present time, he said he was glad to find us taking intelligent interest in the job, and hoped we would keep it up, and eventually become first-class drivers with a full knowledge of the engines. To cut a long story short, as Nat Gubbins would remark, he spent an hour with us explaining many “whys and wherefores ” ; and one of the things he told us was, that a big lead such as ***Fairlight*** had, could not cause any “ back kicking,” because the port on the other cylinder would be wide open, and the crank in the best position to take the thrust. We could see that for ourselves, by observing the position of the cranks, for he directed us to pinch the engine back until the steam port was just cracking, and then take a look underneath. We saw that the crank on the side just open to lead, was only just off the dead centre, and even full steam pressure on the piston head would not have forced it to move in the reverse direction ; whilst the one on the other side was practically right down, the steam port wide open, and the piston “ getting the lot.”

I have tried in these notes to pass on useful information, as followers of them know full well ; but whatever I could write, and in whatever way I could word it, such information could never be so convincing, nor so easily grasped, as when demonstrated on a full-sized locomotive by an official of many years’ practical experience,who knew exactly what he was talking about.

" L.B.S.C."- AN OIL-FIRED

SOME of the builders who have completed the chassis of " Juliet " and intend to fit an oil-fired boiler, are saying " please don't make us wait until the description of the loco-type boiler is finished, or we shall be hung up for a job." All sereny, anything to oblige ! So here is an illustration or two, with a few constructional notes, on the alternative boiler, which will enable them to "get cracking" as soon as they like.



Arrangement of oil-

Beginners might care to learn that in this boiler they once more have the result of practical experience in the actual work of locomotive building, embodied in the design and construction. Your humble servant has overhauled and rebuilt dozens of both commercially- and professionally-made engines with water-tube boilers, and in all of them there have been faults.

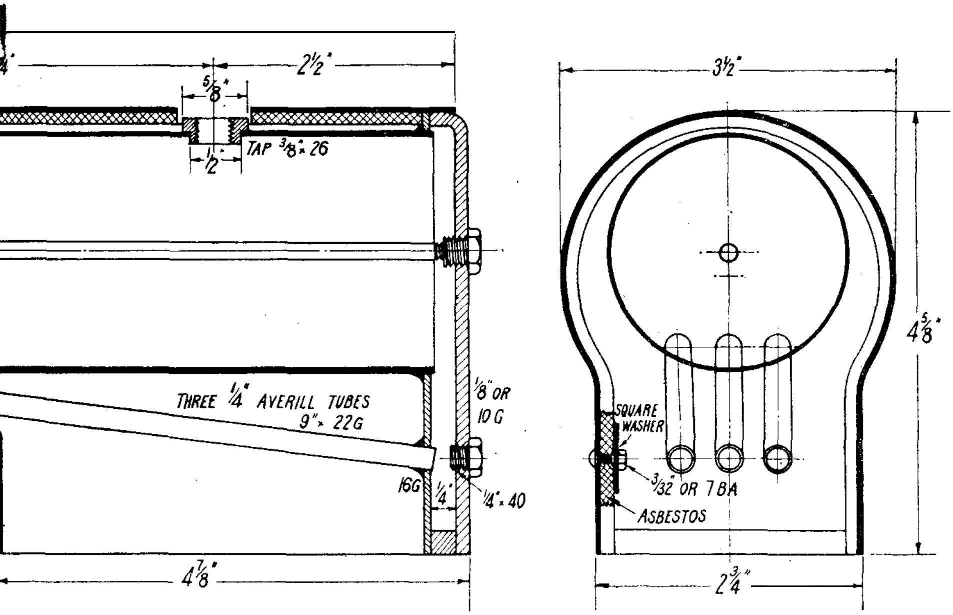
The chief fault of one commercial design in particular was the bunching together of a number of small-diameter water tubes, ranging from five to nine, these having a big swan-neck where they emerged from the barrel at the back end-which was good-then continuing almost to the extreme end of the barrel, right up close to it and parallel with it, which was jolly bad, and then finishing up by entering the barrel with an almost right-angle bend, which was worse still. When getting up steam with an oil-burner on one of these contraptions, it sounded like a machine-gun in action ! The water in the horizontal part of the tubes being rapidly converted into steam, blew the rest of the water out of both ends and left the tube dry. As soon as the steam had gone, back came the water into the tube again ; and immediately it reached the part of the tube in the lamp flame, it flashed into steam and the performance was repeated, until finally the tubes cracked or burst. After several experiences of this kind, I always fitted either a new inside barrel with three tubes only, much larger in the bore, or else cut the small tubes out, plugged the holes, and replaced them by three larger ones. Another fault was that the small tubes became furred up when the boiler had been fed with impure water, and promptly burnt out as soon as the oil burner got busy. With the original " poison-gas-plant " firing, they merely became red-hot, and contributed nothing at all to the steaming of the boiler.

Other boilers had a cast backhead with a water-space at the bottom, something like I have shown here, but retained the small tubes with the horizontal part and sharp bends at the front end. These did not kick up such a shindy as those first mentioned ; but they rapidly burnt out, because any scale and dirt in the water settled at the bottom of the " downcomer," as it was called, and soon blocked up the rear ends of the tubes. One specimen had the downcomer blocked solid, right up to the barrel ; I sawed it off, to see exactly what was in it, and that was what I found.

Other people realised the shortcomings of the usual water-tube boiler, and tried to improve it. The late Mr. T. W. Averill did away with the bends at the leading end, and by distorting the holes after drilling, he gave the tubes a straight

BOILER FOR "JULIET"

run-in. This was an excellent idea which I perpetuated in all the water-tube boilers that I personally built ; you see it on the reproduced drawing. Carson's introduced a cast backhead incorporating two water-legs, into which were fitted two large tubes (about 5/16 in. diameter on 2-1/2in. gauge locomotives), but they still retained the front bends, and there was no provision for cleaning. Several other attempts at improvement came to my notice, but none of them got right to the bottom of the whole business. Anyway, I did a bit of experimenting, and found that by putting in the front ends of the tubes on Mr. Averill's system, and entering the rear ends, not at right-angles to the barrel, but on the slant (the forward and rear parts of the tube being at right-angles, with an easy connecting bend) there was a good circulation set up from front to back, and the tubes kept clean. I used a loco-type backhead of flanged copper, and brazed the inner barrel straight on to it. This type of boiler steamed wonderfully well, but it had one drawback, viz. the amount of backhead space available for fittings and mountings, was limited to the end diameter of the barrel.



fired boiler for "Juliet"

The Final Development

To get more space for fittings-as much, in fact, as on an ordinary loco-type boiler, I took the combined-backhead-and-downcomer idea and made a few improvements. My backhead was of flanged copper sheet, as on a loco-type; the space between the edge of flange and backhead was closed in with a piece of sheet copper, same shape, brazed in. This provided a water-space of the same area as the backhead. A hole for the end of the barrel was cut in the upper part, and the three water-tubes were fitted in holes in the lower part. The water-tubes were perfectly straight, and entered the barrel by Mr. Averill's method of distorted holes. This made the boiler very similar to the well-known Babcock & Wilcox boiler, as far as working principles were concerned. By putting three cleaning-plugs in the backhead, right opposite the ends of the water tubes, they could be cleaned out, and freed from any accumulation of scale or " fur," as easily as sweeping boiler tubes. Any deposit in the bottom of the water space could easily be removed, by stirring it up with a wire through the tube-cleaning holes, or through a special plug placed lower down, and then washed out with a jet of water. The water-space provided extra heating surface, equal to the door plate of an ordinary locomotive firebox ; and to prevent as much as possible the usual waste of heat through the outer casing, same was lined with asbestos millboard. Such is a brief specification of the boiler required for an oil-fired " Juliet " ; and here are a few notes on how to build it.

Outer Shell

The outer shell, comprising the barrel and firebox wrapper, is made from 18-gauge sheet steel, following the general instructions given for the copper loco-type barrel and wrapper, with two variations. One is that the smokebox may, if you so desire, be in one piece with the barrel ; in that case, the barrel part will be 2 in. longer than the loco-type barrel. The end will be carried on a smokebox saddle of the usual type, and the front closed by a casting carrying a dummy door and hinges, this having a spigot turned to a tight push fit in the end of the barrel, and saving all the work of making a separate door and accessories. Secondly, there is no need to braze the joints ; if the lap joint and the throatplate flanges are nicely riveted with 1/16in. iron rivets (brass or copper will do, but iron ones are better for steel work) they will be quite O.K., as there is no water to leak out. Holes are cut in the top as shown, that for the dome being I) in. diameter and 3/4 in. for the safety-valve. If you are using one-piece construction, the chimney hole should be made 3/4 in. diameter, the hole for the blast-Pipe 3/8 in. clearing, and for the steampipe 1/4 in. clearing, the location of the holes being shown on the drawing.

lf a separate smokebox, such as a " Petrolea " casting, is desired, make the barrel same length as that on the loco-type boiler ; that is, 7-1/2 in.

The shell is lined with 1/8in. asbtstos millboard. If this is cut to size, and then wetted, it will bend readily into a tube without cracking, and when dry, will retain the shape of the boiler. The part Inside the barrel will " stay put " if the edges are just butted together ;the part inside the firebox casing can be secured by four large washers, about 3/4 in. square, made from the same stuff as used for the shell, and fixed by a 3/32-in. or 7-B.A. screw and nut through the middle, as shown in the cross-section. Cut away the asbestos, of course, where it blocks the dome and safety-valve holes, and leave about 1/4 in. of the firebox casing clear at the back end.

Backhead

The backhead is made from 1/8in. sheet-copper, same as the loco-type, but allow for the flange to be a full 1/4in. depth, measured on the inside. File off any raggedness, so that the flange is smooth-edged all the way round, and of equal depth. Now cut a piece of 16-gauge sheet-copper slightly larger than the backhead itself; in this, cut a 2-1/2in. hole, and drill three 1/4in. holes, at the positions shown in the illustration. See that this is perfectly flat, and that the backhead flange, when same is laid on it, makes full contact all round. Next, cut a piece of 1/4in. square copper rod, and fit it between the backhead flanges, exactly as described for the foundation-ring of the loco-type boiler. Temporarily clamp the plate against the backhead flange, and put three rivets through plate, piece of rod, and backhead, same as described for the throatplate section of the foundation-ring of the loco-type boiler. Now lay the assembly in the brazing pan, plate down, and backhead on top ;if the plate springs away from the flange, either tie the parts together with some thin iron binding-wire, or put something on top that won't hurt by being heated. Apply wet flux all around the joint, and braze it, using easy-running strip, or else Sifbronze it. Don't use silver-solder for this job, as it will either melt or crack open when doing the barrel joint. Pickle, wash off, and clean up. Now put a 1/4in. drill through the tube holes, and make countersinks on the inside of the backhead ; follow **up** with a 7/32in. drill, and tap 1/4 in. by 40, working the tap through from the backhead side.

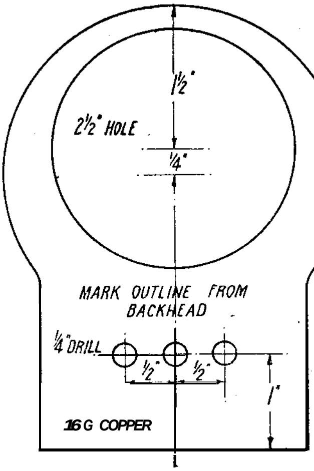
An alternative method of fitting the plate is shown in the small detail sketch. In this, the plate is cut to fit inside the backhead flange, and the bottom edge is bent in to meet the backhead, thus dispensing with the piece of foundation-ring. The backhead flange must be at least 3/8 in. deep inside, for this form of construction, to allow for the 1/4in. water-space, and a little fillet of spelter all around the joint ; otherwise there is nothing to choose between either method of construction. If using the first described, leave the plate projecting beyond the backhead flange until the larger part of the brazing and silver-soldering is completed ; it can then be filed flush with the backhead flange before assembling into the outer casing.

Inside Barrel

A piece of 2-1/2in. by 18-gauge seamless copper tube, measuring II-1/2 in. long after. the ends have been squared off, is needed for the inside barrel. One end of this is closed by a flanged 16-gauge copper plate made exactly as described for the smokebox tubeplate of the loco-type boiler. Drill a 9/32-in. hole in the middle. and tap it 5/16in. by 40 ;drive the plate in flush with the knd of the barrel. At 4-1/4 in. from the closed end, drill three 1/4in. holes at 1/2in. centres. As the tube will probably be hard, you can kill two birds with one shot here, brazing (or silver-soldering with coarse-grade silver-sdder, such as Johnson-Matthey's B6 alloy) the end of the barrel, and softening the metal round the tube holes. After pickling, washing and cleaning, insert a bit of 1/4in. round steel rod in each tube hole, and force it down into the position shown by the tubes in the longitudinal section of the boiler.

Cut Three pieces of 1/4in. by 22-gauge copper tube, each 9-in. long ; well clean the ends, and insert one on each tube hole. Now put the open end of the barrel into the big hole in the backhead assembly, and the ends of the water tubes in the small holes, carefully lining up the whole issue, so that the tubes lie parallel with the centre line of the barrel. The joint between the barrel tube and the backhead plate, and both ends of the water-tubes are then silver-soldered with coarse grzde silver-solder or B6 alloy. Stand the assembly in the brazing pan on a layer of coke, with the barrel pointing skyward, put some wet flux (I use either Boron compo or Tenacity No. I for jobs like these) around barrel and tubes, and heat up the whole doings with a blowlamp, until hot enough to melt the silver-solder when applied. A 2-1/2pint lamp is quite man enough for this job ; in fact, a 1-pint lamp will do it, if it is well pumped up, and the party behind it has patience enough to hold it until sufficient "therms " have been applied to the boiler.

After doing the back end, lay the barrel on its back in the coke (no need to pack around it) and blow straight on to the ends of the tubes in. the distorted holes until they, and the surrounding metal, are hot enough to melt the silver-solder. I recommend beginners to use a blowlamp for this job, because, even if they possess an oxy-acetylene outfit, it needs great care in using, to avoid burnt tubes. If I use my " Alda," I put a big tip in it, and adjust the gas pressures for a big diffused flame that burns silently without any hissing at all. An oxy-coal-gas blowpipe is ideal for the job, but Mr. Shinwell might raise objections.



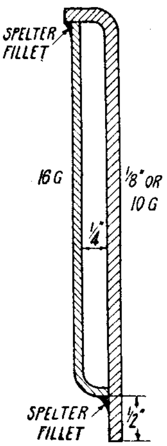
Inner plate for backhead

Pickle, wash off, clean up and file the backhead plate flush with the flange; then try the assembly in the steel casing. Temporarily clamp in position and mark off the location of the dome and safety-valve bushes, through the respective holes in the casing; then remove the inside assembly, drill the holes as described for the loco-type boiler, and fit the bushes, which are also the same as the loco-type. These can easily be silver-soldered in by giving them a dose of " Easyflo " flux (Tenacity No. 3), blowing straight on them with the blowlamp flame-no coke packing required-and applying a little " Easyflo " ; failing that, use borax-and-water paste and No. 1 grade or best silver-solder. Pickle and clean up, and Bob's your uncle as far as blowpipe artistry is concerned. Billy Muggins himself ought to be able to make a first-class job of such a simple boiler, with a little pluck, patience and perseverance!

Staying and Assembly

One solitary longitudinal stay is required, and that is exactly the same as described for the solid longitudinal stays of the " Lassie," being a piece of 3/16in. copper rod I1-1/2in. long, screwed 3/16in. by 40 at each end, and furnished with a couple of blind nipples made from 3/8in. hexagon rod, screwed 5/16in. by 40, and the whole doings inserted as described for the " Lassie." If you put a smear of plumber's jointing around the threads on the nipples, you won't have any Welsh vegetables growing around them. The hole in the backhead, for the nipple at that end, is drilled and tapped exactly 1/4 in. above the centre-line of the outer casing. No stays are needed in the water-space at the bottom of the backhead, as the three tubes silver-soldered into the inner plate will effectually prevent any tendency to bulge it out ; whilst the thickness of the backhead itself enables, it to stand the pressure without the aid of any additional staying.

To hold the boiler in place in the outer shell, drill a few No. **41** holes around the firebox end of the steel casing, 3/16 in. from the edge ; one opposite each end of the "piece of foundation ring " at the bottom, and, say, three more each side at about I-1/2in. centres. Put the boiler in the casing, adjusting it so that the backhead is vertical, and projecting about 1/8 in., as shown in the longitudinal section ; the dome and safety-valve bushes should line up with their respective holes in the casing, and the inside boiler barrel should lie horizontal, as shown. Run the No. 41 drill through the holes in the casing, with the inside assembly temporarily clamped in place, and make countersinks on the backhead flange ; follow up with No. 48, and tap either 3/32 in. or 7 B.A. Use brass round-head screws for fixing, with a smear of plumber's jointing on the threads. It won't matter a bean about these screws piercing the water-space, if brass screws are used, and the threads are O.K. You have to screw the fittings into the water-space, and no water leaks around the threads of those when fitted properly!



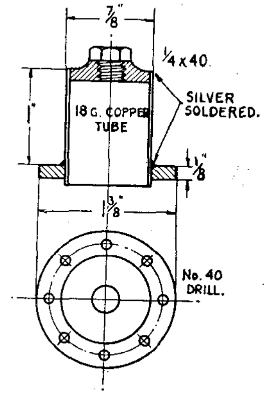
Alternative arrangement of backhead

The front end of the casing is closed by a casting representing an ordinary smokebox front with door and hinges, which our advertisers will be able to supply. It should have a chucking-piece cast on the front ; and all the turning it needs is merely chucking this in the three-jaw and turning the step to a tight push fit in the end of the casing, as shown in the longitudinal section. You can reverse it in the chuck, and grip by the turned edge, then face or part-off the chucking-piece, centre it, drill No. 48 and tap 3/32 in. or 7-B.A. for the stem of a pair of dummy handles, for sake of appearance. As mentioned earlier, anybody who wishes to fit a separate smokebox can do so. The complete cast smokebox which needs no saddle, as specified for " Petrolea," is just right for this engine, and can be used by making the barrel of the casing **2** in. shorter than shown (that is, 7-1/2 in. from end of barrel to throatplate) and fitting the smokebox exactly as I shall describe for the loco-type boiler. A separate smokebox can also be made from a 2-1/8in. length of 3-5/8in. brass tube ; this will also be described in connection with the loco-type boiler, also the saddle, which is needed to support it. As the whole_ of the backhead is a " water area," same as on the loco-type boiler, the arrangement of fittings, regulator, blower, gauges and so on, will be the same, except for the addition of the feed clacks, which will have to go on the backhead instead of on the sides of the barrel.

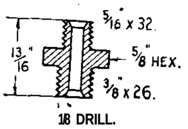
“ L.B.S.C.”

TESTING “JULIET’S” BOILER

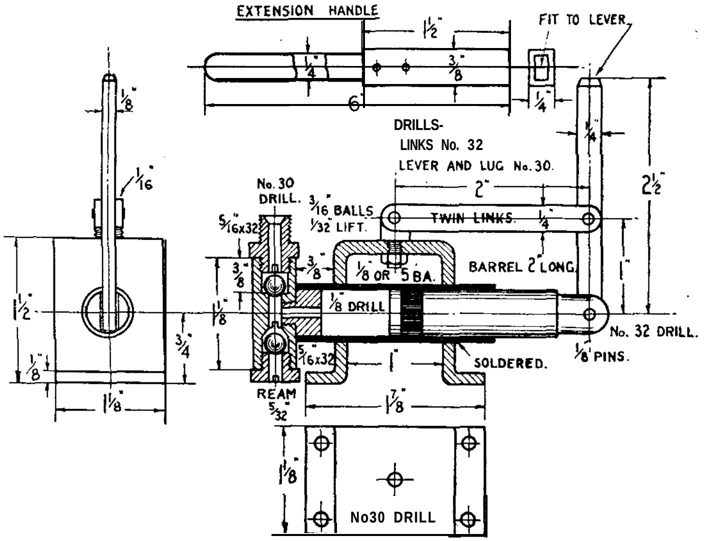
IT is only just recently that I described how to test “ Hielan’ Lassie’s ” boiler, so there is hardly any need to set out the whole doings in full detail again ; however, for beginners’ benefit, here is a brief summary, with details and illustrations of the inner dome, and emergency hand pump, which will be used for the job. To reassure any nervous souls who might be terrified at the idea of putting a lot of pressure in the boiler, and getting a big bang if their workmanship doesn’t stand the strain, there is no danger whatever. If anything gave way, the pressure would immediately be released without the least chance of explosion ; there might be a tiny crack, hardly audible, and the worst damage the operator could sustain, would be a few drops of water either on his clothes or personal anatomy. Nothing more-though maybe his peace of mind would be upset ! But be of good cheer ; if you have faithfully followed the “ directions on the label,” there won’t be as much as a solitary tear-drop escaping where it shouldn’t. One big advantage of building a little steam locomotive is that you don’t have to be an expert of many years’ standing, to make a success of it. Well, to business.



Inner dome



Adapter for testing boiler



Emergency hand pump

Inner Dome

The inner dome may be either cast or built up. If a casting is used, it only needs chucking by the body, and the underside of the flange faced up with a knife-tool, to make contact with the dome bush. A slight projection is turned below the flange, to fit inside the bush, like the register of a cylinder cover. The casting is then reversed in the chuck, and the top faced off, centred, drilled No. 3 or 7/32-in. and tapped 1/4 in. by 40 for an oiling plug for the regulator.

To make a built-up dome, cut a piece of 7/8in. copper tube 18-gauge for preference, though 16 or 20 can be used-to a length of about 10-in. Chuck in three-jaw and face off each end, so that the finished length is 1-1/4 in. On a piece of 1/8in, sheet brass, mark out a circle 1-3/8 in. diameter, and another 7/8 in. diameter inside it. Saw out roughly to shape ; then chuck in three-jaw, centre, drill a pilot-hole about 3/16 in., and if you have not got a 7/8in. drill, poke the biggest one you have, through the plate, and then bore out with an ordinary boring tool, until the hole is a drive-fit for the piece of 7/8in. tube.If you have a piece of brass rod 7/8 in. or over, chuck in three-jaw, and turn the end of it to the outline shown in the illustration, slightly chamfering the edge. Centre, drill 7/32 in. for about 5/16in. depth, tap 1/4in. by 40, and countersink the hole slightly. Turn down about 3/16in. length to a drive-fit in the 7/8in. tube, and part off about 3/16 in. from the end.

If you haven’t a piece of rod big enough, cut out a disc of 1/16in. sheet copper, and drive it tightly in the end of the tube ; chuck in three-jaw, centre the disc, drill it 5/16 in., and make a bush to fit it, like the safety-valve bush, only use 3/8in. rod, shouldered down to a tight fit in the

5/16in. hole. Drill 7/32 in., tap 1/4 in. by 40, countersink slightly, and part-off about 3/32 in. behind the shoulder. Put the big flange on the bottom end, leaving about 1/16 in. of the g-in. tube projecting ; then silver-solder both ends at one heat. After pickling and cleaning up, chuck the body of the-fitting-in the three-jaw, same as a casting, and take a skim off the contact side of the flange, with a knife-tool, to ensure proper contact with the bush in the boiler ; also turn the flange to 1-3/8 in. diameter.

Whether cast or built-up construction is used, drill eight No. 40 holes in the flange, and scrape or file off any burring. Make a little plug for the hole in the top, using 5/16in. hexagon rod. Put the dome in position on the bush, and run the 40-drill through one of the holes, making a countersink on the bush. Remove dome, drill out the countersink with No. 48 drill, and tap 3/32 in. or 7-B.A. Replace dome, and secure temporarily with a single screw ; then “ ditto repeato ”be process on the other seven at one fell swoop, just like fitting a cylinder cover. Finally, assemble with a 1/64-in. Hallite or similar joint-gasket between dome and flange ; and use brass screws, either round or cheese-head, for fixing permanently.

Testing Adapters

Two of these are needed ; only a few minutes' work apiece. Chuck a piece of 5/8in. hexagon brass rod in three-jaw ; face the end, and centre deeply. Turn down 5/16 in. of outside to 3/8 in. diameter, and screw 3/8 in. by 26, to match the safety-valve bush. Part off at 13/16 in. from end; reverse in chuck, centre deeply and drill right through with 1/8in. or No. 30 drill. Turn down 1/4in. of the outside to 5/16in. diameter, screw 5/16in. by 32, and you're through. Make another one, but instead of screwing the bottom end 3/8 in. by 26, screw it 3/8 in. by 40, to match the hole in the smokebox tubeplate.

Emergency Hand Pump

As the emergency hand pump does fine for the boiler test, it can be made right away, and put aside after test, until the side tanks are fitted. The construction is the same as “ Lassie's,” and very similar to the eccentric-driven pump only just recently illustrated ; so a short description should suffice. No castings are needed. The stand is made from a piece of brass or copper 1/8 in. in thickness, 1-1/8 in. wide and approximately 44 in. long, bent to the shape shown. I use a piece of 1-in. square iron bar for doing this job, first bending the arch over the bar, then putting same in vice with the bar between the “ legs,” the latter pointing skyward, and then knocking them outwards, flat on the tons of the vice-jaws. The whole-process takes only a few minutes. Drill a No. 30 hole in each corner, one in the top of the arch, and one in the middle of each side. Open out the latter with a 35/64-in. drill (or the nearest smaller available) and ream 9/16 in. ; the hole should be a tight fit on the 9/16in. barrel tube.

The valve-box is a 1-1/8in. length of 7/16in. brass rod sauared off at both ends in the lathe. drilled right through with No. 24 drill. The valve-chambers are formed exactly as described for the eccentric-driven pump, using 9/32-in. drill and D-bit, and tapping 5/16 in. by 32. Ream the centre part 5/32 in., and use 3/16-in. balls, allowing 1/32 in. lift. The upper cap is the same as the eccentric-driven pump, except that it is screwed 5/16 in. by 32 instead of 3/8 in. ; and the lower cap has no threaded part below the hexagon, which is turned off flush, and cross-nicked with file or hacksaw. A 7/32in. hole is drilled in the side of the valve-box between the ball chambers, and tapped 1/4 in. by 40.

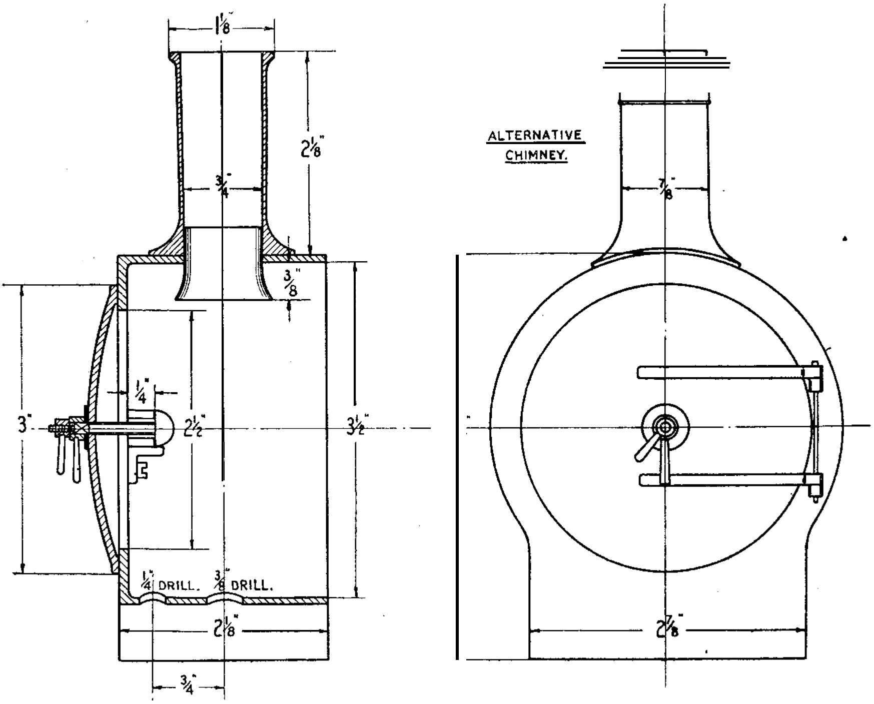
The barrel is a 2-in. length of 9/16in. brass treblet tube, squared off at both ends. A brass plug is turned to fit tightly in one end, and the end of this is shouldered down to 1/4 in. diameter, and screwed to fit the hole in valve-box. The tube is then pushed through the holes in stand, with valve-box vertical, and D-bitted end uppermost ; sweat over the joint between barrel and valve-box, and where the tube passes through the stand.

The ram is a 2-1/4in. length, of 1/2in. bronze, gunmetal or rustless-steel rod. which should be an exact sliding-fit for the treblet-tube barrel, and should not need turning ; but if the tube is over 1/2 in. in the bore, the ram must be turned to fit, from a suitable piece of rod metal. One end is reduced to 3/8in. diameter for 1/2in. length, and slotted to accommodate the operating lever, also cross-drilled with No. 32 drill for a 1/8in. pin. The other end has a groove 1/8in. wide and same depth, turned in it 1/8 in. from the end. This is packed, preferably with a bit of unravelled hydraulic pump packing ; but if this is not available, a few strands of graphited yarn will do, same as used for pistons and glands. The lever is a a 2-1/2in. length of 1/8in. by 1/4in. brass or nickel-bronze rod, with two No. 30 holes in it ; one at bottom, and the other 1 in. above it. Two links, of 1/4in, by 1/16in. brass or nickel-bronze rod, with No. 32 holes drilled at 2-in. centres, are pinned to the upper hole. The other ends are pinned to a lug made from same kind of material as lever, turned down to 1/8 in. diameter at bottom, screwed 1/8 in. or 5-B.A., put through the hole in the top of the stand, and secured by a brass nut.

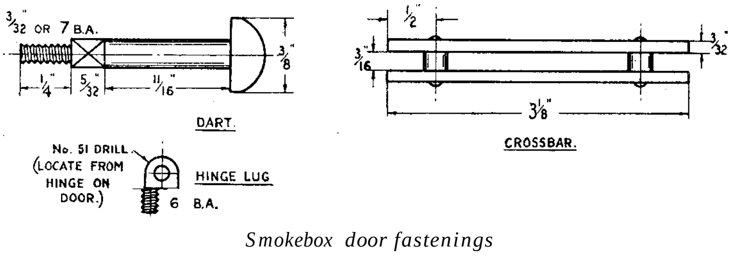
When in position on the engine, the pump will be operated by an extension handle worked through the filling hole in one of the side tanks. This handle will be needed when testing the boiler, to get sufficient leverage to pump up the required pressure. It is merely a 5-in. length of the same kind of rod as used for the pump lever, with a socket on one end, to fit over the lever. This socket may be either a 1-1/2in. length of 3/8in. by 1/4in. rectangular tube (commercial article sold by metal merchants) or a piece of 16-gauge sheet-brass bent around the pump handle to correct outline, and the joint silver-soldered, also letting the silver-solder fix the socket to the handle instead of using the rivets shown. The above condensed description of the emergency pump, plus the illustrations, should enable anybody who has made the eccentric-driven pump, to make the hand-operated one. I nicknamedit my “ two-hour ” pump, because that was exactly long it took me to make one at the time I first introduced it to readers of these notes. I can do them a bit quicker now, especially by making three or four at one go. Its capacity per stroke is about four times that of the ridiculous type of commercial pump in which the lever is pivoted to the base, and the undersize ram passes through an outsize in external glands.

Rig-up for Testing

To make the actual test, screw the adapters into the safety-valve bush and the hole in the smokebox tube-plate. Connect the former to a pressure-gauge reading to 200 lb. or over. *Don't* on any account use the gauge you will be fixing on the boiler to indicate steam pressure in service, or you will " do it in " ; these little gauges are not suitable for such strenuous jobs. A full-size steam-gauge, or a hydraulic gauge such as used for indicating oil or water pressure on small hydraulic jacks or presses, is O.K. for the job ; I use a full-size locomotive gauge reading to 360 lb. The other adapter is connected to the top of the pump valve-box, both connections being made by bits of copper tube with suitable union-nuts and cones on the ends, and the pump is placed in a pan of water. Take out the screw plug on top of the dome, and fill the boiler completely with cold water, right up to the plug, which is then replaced tightly. A very few strokes of the pump will send the gauge needle up to 50 lb., at which point the boiler should be examined for leaks and bulges. If all O.K., raise the pressure gradually to 160 lb. with pauses for a " looksee" at about every 30 lb. increase, to see if anything untoward is happening. If you arrive at 160 lb. without a " bust-up " as the kiddies say, and the boiler holds it all right, you can take your competent boilersmith's certificate. A slight movement of the crown-sheet, or any other part of the boiler, as the pressure rises, provided it is no more than about 1/32 in., is of no consequence, as it will be due to the copper, softened by the brazing process, merely taking up the best position to resist the stress. Let off the pressure and empty out the water, and the boiler is now ready for smokebox and various other adornments. Should any leak have developed during the test, it should, of course, be remedied before proceeding any further.



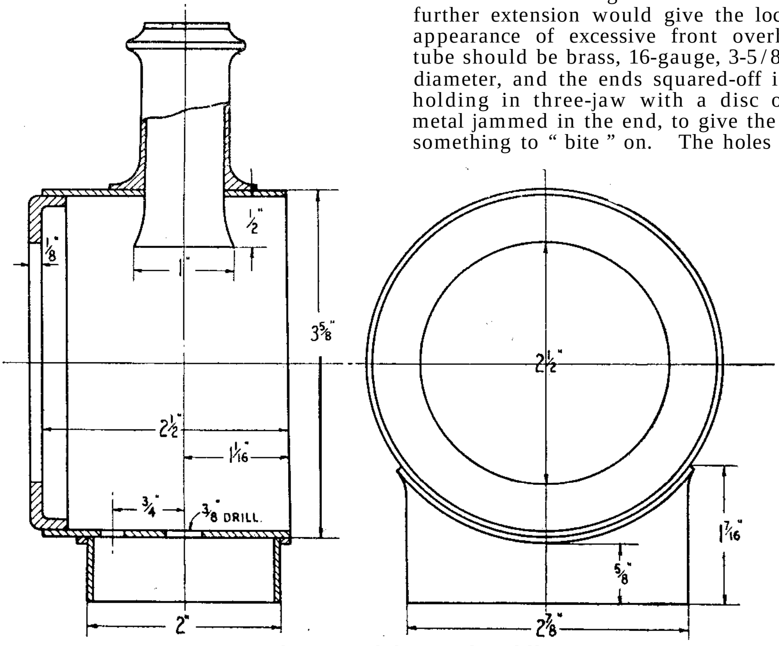
Cast smokebox for " Juliet"



Smokebox door fastenings

Smokebox-Cast Pattern

The smokebox I recommend for " Juliet " is the simple one-piece casting as supplied for " Petrolea," as this does away with a separate ring or front-plate! and dispenses with a saddle. However, if a casting is not easily obtainable, an alternative drawing is given, showing a smokebox made from tube, and mounted on a saddle, which may be either a casting, or built up. The cast smokebox is easy to machine. Chuck in four-jaw with the open end outwards, and set it to run truly. Face-off the end with a round-nose tool set crosswise in the rest ; then, with an ordinary boring-tool, bore out the inside to a tight push-fit for the boiler barrel, to a depth of about 3/8 in. Reverse in chuck, and face-off the front. The outside can be smoothed down with a file, and finished with emery-cloth. Drill a 7/8in. hole in the top, for the chimney liner ; and exactly opposite, at the bottom, a 3/8in. hole for the blast-pipe. At 3/4 in. ahead of the blast-pipe hole, drill a 1/4in. hole for the steam-pipe ; or if the union is silver-soldered to the pipe, make the hole big enough for the union to pass through. Beginners note, the best way to get the chimney hole right, is to scribe a circle on top of the smokebox ; drill a small hole first, say 3/16in., then open it out by stages ; and if the 7/8in. hole isn't going to line up with the circle, you'll be able to correct it with a file, before getting to the full size.



Built-up smokebox and saddle

A cast door will be supplied with the cast smokebox. Very little machining will be needed on that ; just chuck in three-jaw by the chucking-piece provided, and face-off the contact edge with a round-nose tool set crosswise in the rest. Don't run too fast, or the facing will be covered with chattermarks, and the door won't close airtight. Centre, and drill a No. 30 hole through the whole lot, door and chucking piece ; then either reverse the door in the chuck, gripping by the edge in the outside jaws, and face-off the chucking-piece, or else saw it off, and give the " stump " a truing-up skim. The doo is fitted as described below for the built up contraption.

Smokebox Made from Tube

Some folk like to see a smokebox extended to pouter-pigeon dimensions ; there's no accounting for some folk's tastes, as the waitress said when the customer put a kipper into a plate of mutton broth ! A smokebox made from tube may either be cut to the dimension given for the cast variety, or it may be made a little longer, as in the accompanying illustration, which shows an alternative tube smokebox 2-1/2in. long. This would be suitable for an engine of " Juliet's " type ; a further extension would give the locomotive an appearance of excessive front overhang. The tube should be brass, 16-gauge, 3-5/8 in. outside diameter, and the ends squared-off in the lathe, holding in three-jaw with a disc of wood or metal jammed in the end, to give the chuck-jaws something to " bite " on. The holes for chimney and pipes, are drilled 1-1/16 in. from the boiler end. The ring, or smokebox front, is knocked up from a disc of 1/8in. brass about 4 in. diameter, over the former used for the smokebox tube-plate. The ragged edge is skimmed off and the flange turned to fit the smokebox, as described for the tube-plate ; but the convex side is faced off, with the flange held by the outside, in the three-jaw, and a hole 2-1/2 in. diameter cut by aid of a parting-tool.

A cast door may be used with this type of front, or you can make one from a brass disc 1/8 in. thick and a little over 3 in. diameter. Anneal it, and lay on a block of lead ; hit it with the ball-end of the hammer, starting from the middle and going around in a circle, until it looks like a saucer. Then chuck in three-jaw, gripping by the edge, concave side out ; face off the edge to form a contact ring with the smokebox front.

Centre, and drill a No. 30 hole through ; face a piece in the centre, around the hole, about fin. diameter. Chuck a piece of brass rod about 5/8 in. diameter, and turn a pip on the end, to fit the hole. Drive it in, and solder the rod to the facing. The bit of rod then forms a chucking-piece, which is held in the three-jaw, and enables the door to be turned all over the convex side and reduced to correct diameter at the one setting. Inexperienced lathe hands will find it a ticklish job to turn the convex side without umpteen tool marks showing. I usually finish mine with a hand graver ; but a smooth. file applied judiciously, and followed with emery-cloth or other abrasive, will do the trick. Always spread a rag, or sheet of paper, over the lathe-bed when using emery-cloth, otherwise the confounded stuff will get into the screws and slides, and play old Harry. Lathes are dear nowadays ! Melt out the chucking piece ; make a couple of hinge-straps from 1/8in. by 18-gauge strip (nickel-bronze will do) riveted on with domestic pins. Mention of those always reminds me of an old friend who rang me up one evening at Norbury, many years ago, and wanted to know what the heck " dome-stick " pins were! The loops at the end, for the hinge-pin, are made by bending the strip into a loop with a small pair of round-nose pliers, and silver-soldering the joint. Don't be alarmed if the loop gets filled up solid-just put a No. 51 drill through it !

Door Fixing

Either type of door is attached to either type of smokebox in the same way. Turn up a couple of little lugs from 1/8in. by 1/4in. flat brass rod chucked truly in four-jaw, as shown in detail sketch, but don't drill them yet. Then make up the cross-bar and dart ; the former is merely two 3-1/8in. lengths of 3/32in. by 1/4in. black steel strip with 3/16in. spacers at 1/2 in. from each end, riveted together with 3/32-in. iron rivets. The dart is turned from 3/8in. round mild-steel held in three-jaw. Turn down 1 3/32-in. length to 1/8 in. diameter ; further reduce 1/4 in. to 3/32 in. diameter and screw 7-B.A. or 3/32-in. File a square 5/32-in. long, immediately behind this. Part off to leave a head 3/16 in. long, and file to shape shown, flattening same to 1/8in. to match the spindle.The " key " is a 3/16in. slice of 1/4in. steel rod, with a 3/32-in. hole drilled in it, and filed square to fit the dart. The locking-handle is a 3/16in. slice of3/16in. rod, drilled and tapped to match the screw on the dart. Both have a handle made of 15-gauge spoke-wire, either screwed or silver-soldered into them, as shown in the illustrations.

Hold the crossbar temporarily in position at the back, of the smokebox front (says Pat) put on the door, and assemble as shown in section ; adjust door so that hinges are horizontal, and door itself quite central. Then fix two brackets, bent-up from 16-gauge sheet-steel, to support the cross-bar, attaching them to the smokebox ring by screws, and mark the position of the lugs immediately below the hinges. Drill No. 44 holes 1/16 in. below the ends of the hinges, tap 6-B.A. and screw in the lugs, with door removed. Replace door, run the 51 drill through holes in hinge ends, and carry on through the lugs. For this job, I use a short bit of drill fixed in the end of a piece of 1/8in. silver-steel. Make the hinge-pin out of a bit of 16-gauge steel-wire with the top burred over, or a little boss screwed on to it ; trim up the lugs to match the hinges, and Bob's, your uncle !

The saddle for supporting a tube smokebox may be either a casting, which will only need cleaning up with a file, or built-up. In the latter case, cut four pieces of 16-gauge metal to the dimensions shown, and assemble in the form of an oblong, either by brazing at the corners, or' riveting in small pieces of angle. The flanged saddle-plate on which the barrel of the smokebox. rests, is a piece of 16-gauge metal, 2-1/4in. by 3-1/2in., with the middle part cut out to let the pipes pass,, bent to the same radius as the outside of the smokebox shell, and brazed or silver-soldered to the top of the saddle. It is secured to the smokebox by three or four 3/32-in. screws, roundhead for sake of appearance, run through clearing, holes in the edge of the flange, into tapped holes, in the smokebox shell.

The chimney can be any type you fancy. I prefer the plain stovepipe, as fitted to " Petrolea,'" also used by Bill Adams, Bob Urie, and other locomotive engineers of the good old days. Some of the old L.S.W.R. drivers swore by all that was holy (or otherwise !) that Adams's engines never steamed so well when the original chimneys were replaced by Drummond's type. Anyway, that won't apply to " Juliet," so I have shown three alternatives. All are turned up from castings, and attached to the smokebox top by four 3/32-in. or 7-B.A. screws run through the flange, into the smokebox shell. The liner is merely a short bell--mouth extension, to help guide the steam from blower and blast-pipe up the liner ; and it consists of a piece of 3/4in. tube, 3/4 in. long, softened,, belled out at the bottom, and pushed up into the chimney from inside the smokebox. If a tight push-fit, nothing further will be needed. The bell-mouth can be formed by driving a bit of tapered steel, or a hardwood handle end, into the softened tube ; or maybe our advertisers could supply a little casting that could be turned and bored to dimensions required.

Starting Speedboats by Remote Control

THE starter batteries which will provide the initial impulse to the Goblin II gas-turbine jet-propelled engine of *Bluebird II*, when Sir Malcolm Campbell attempts to raise his own world's water speed record, will not be housed on the boat.

A standard Exide battery has been fitted to each of the two starting launches. The battery in the first launch will be used to start the engine on the outward run, whilst its counterpart will take over the job before the return lap. This is necessary because Sir Malcolm may 'have to switch off his engine at the end of the first lap in order to effect a turn-otherwise the momentum might be too great to allow him to bring his boat around with safety.

"L.B.S.C."

"JULIET'S" REGULATOR

AS our simple little lady needs a simple little regulator, I have specified the disc-in-a-tube type, the Curly version of which is easy to make, gives good regulation, and keeps steam-tight. From time to time, various claims have been made for the " invention" of this ; but they are all unwarranted, because I have here at the present minute a sectional drawing of a full-size locomotive built a hundred and ten years ago, when Queen Victoria ascended the throne of England, and it shows a regulator of this pattern ! The difference is that there are four rectangular ports in the valve face and four similar openings in the disc, like the ventilators on what the old enginemen used to call " cookshop " windows. The stops were on the backhead, over the gland, and were rather clumsy. The regulator opened all-of-a-sudden-Peggy, as all four ports started to open at the same time ; but it certainly allowed a full flow of steam to the cylinders, which was very necessary in those days, on account of the low boiler pressures used, the one in this case being 50 lb. only. When this type of regulator was applied to small boilers, it was adopted "lock, stock and barrel," using four round holes instead of rectangular ports, and retaining the ugly outside stops ; it didn't give gradual admission, but, like its prototype, was "all or nothing." Your humble servant's version does away with both the outside stops and the non-regulating propensities ; and this is how you can make one, suitable either for locotype or water-tube boilers.

Barrel and Valve

The barrel is a piece of 5/8in. brass triblet tube, squared off at both ends in the lathe to a length of 2 in. Ordinary copper or brass tube will also do, but it should not be thicker than 20-gauge. Drill a 7/32-in. hole in the middle, and tap it 1/4 in. by 40 for the vertical steam pipe.

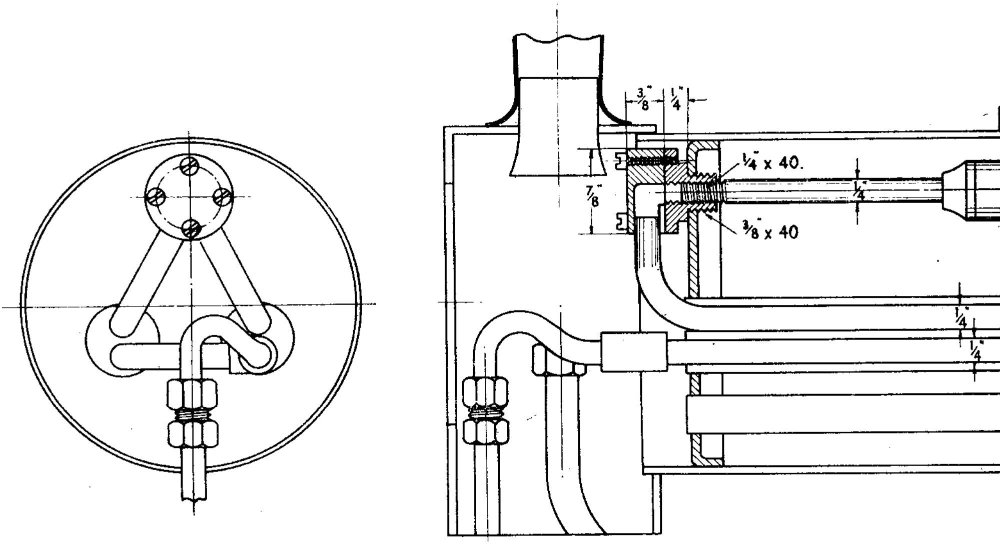
For the throttle-block, chuck a piece of 5/8in. round brass rod in three-jaw. Face the end, centre, drill 1/8 in. depth with No. 48 drill, tap 3/32 in. or 7-B.A., and slightly countersink the hole. Turn down 1/4 in. of the outside to a tight fit in the tube, and part off at 5/8 in. from the end. Reverse in chuck, and grip by the turned part. Centre the other end, drill about 5/16 in. depth with 7/32-in. drill, tap 1/4 in. by 40, and turn the outside to the shape shown. Now be careful over the next bit : make two centre-pops a shade over 3/32 in. apart, on the turned face, not quite halfway between the edge and the centre hole, and drill them out on the slant, with a 3/32-in. drill, until it breaks through-not breaks off !- into the tapped hole, as shown in the longitudinal section. My usual practice is to do this job by hand, using a Millers' Falls hand-brace, with the drill projecting just far enough from the jaws, to drill the required depth. The block is held in the bench-vice at the necessary angle, and the brace held horizontally ; a tip for beginners. Now, with a watchmaker's needle file, or an Abrafile, run the two holes into an oval slot, and with a small chisel, home-made from a bit of 1/8in. silver-steel, chip one end of the slot to an arrow-point, as shown in the illustration of the port face. The hole for the stop-pin is drilled No. 48, close to the edge, in the position of the hour-hand of a clock at 7:30; tap it 3/32 in. or 7-B.A. True up the port face exactly as described for the slide-valves, and screw in two little stubs of 3/32-in. round rod ; bronze if you have it ; if not, use brass.

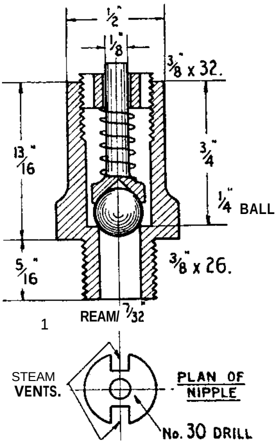
Bronze rod is best for the valve, as dissimilar metals, unlike human beings, work best together, and a bronze valve will wear longer and remain steam-tight ; but brass will do if nothing better is available. Chuck a piece of 5/8in. round rod in three-jaw, face the end, and turn down about 1/2 in. length to an easy fit in the barrel tube. Further reduce 1/4in. length to 1/4in. diameter, and part-off at a full 3/8 in. from the end. Reverse in chuck, centre, *drill* through with No. 40 drill, and countersink slightly. Take a truing-up skim off the face. Centre-pop and drill the port, same as on the port face, but leave the ends round. File a segment out of the opposite end, as shown, so that when the faces are in contact the port will be wide open when the pin is at one end of the gap, and completely closed, with about 1/32 in. overlap for safety, when the pin is at the other end. As the valve is moved from the " shut " position, the port in it first uncovers the arrow-pointed end of the steam port, and enables the engine to be started off with a heavy load, without making her slip by too sudden steam admission. Face the valve truly, same as the slide-valves, by rubbing lightly on a bit of fine emery-cloth or other abrasive, laid working face up, on the lathe-bed or any similar true surface. The faint scratches hold the oil. A slot 3/32 in. wide and a full 3/16 in. deep, is milled, or sawn and filed, across the boss, to take the flattened end of the operating rod.

Chuck the 5/8in. brass rod again, and turn down about 1/2 in. of it to a tight fit in the barrel tube. Centre, and drill 1/2 in. depth with No. 20 drill. Open out to 1/4 in. depth with 11/32-in. drill, and tap 3/8 in. by 40. Part-off at 3/8 in. from the end ; reverse in chuck and skim off any burring around the centre hole.

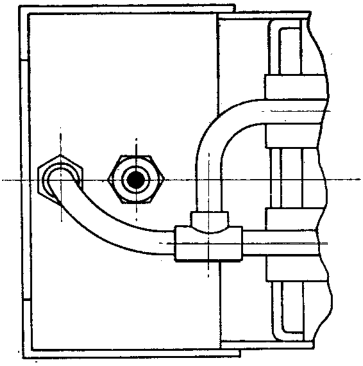
Operating Gear

The regulator-rod is a piece of 5/32-in. rustless steel, nickel, phosphor-bronze or brass rod, cut to an overall length of 9-3/16 in. One end has two flats filed or milled on it, to form a tongue a bare 3/16in. long, which should be an easy fit in the slot in the boss of the valve. Turn down about 5/32 in. of the other end to 3/32 in. diameter, and screw it 3/32 in. or 7-B.A. ; the 5/32 in. immediately behind it is filed square, to take the boss

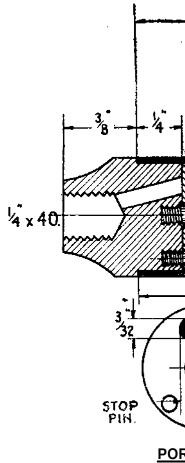




Safety-valve

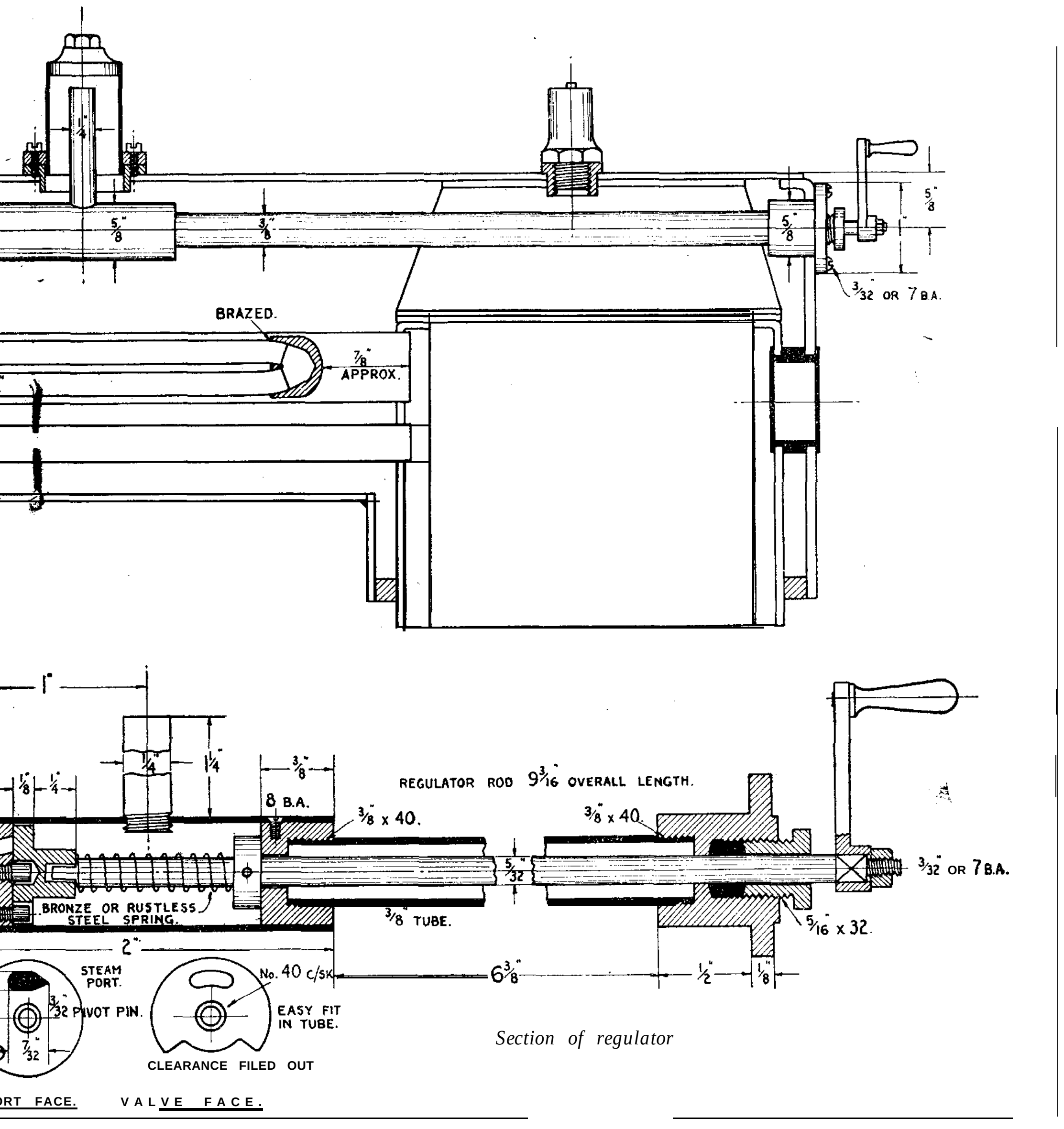


" Juliet's" regulator and superheater



of the regulator-handle. Chuck a piece of 3/8in. round brass rod in the three-jaw ; face, centre, drill down about 1/4 in. with No. 23 drill, and part off 3/16 in. from the end. Drive this collar on to the tongued end of the regulator-rod at approximately I in. from the tip of the tongue.

Squeeze the throttle-block into the end of the barrel, with the steam-port at the top ; that is, in line with the steam-pipe hole in the barrel. Put the valve in, insert the rod with the tongue in the valve slot, and push in the end plug flush with the end of the barrel. If the regulator-rod has about 1/32 in. end play, it is O.K. ; if not, adjust the collar on the rod until you get that amount. If it has no play at all, it will jam the valve ; and if too much, the valve will come off the face and leak. Pin the collar to the rod by drilling a No. 48 hole through it and the spindle, and driving in a bit of bronze or brass wire. Wind up a spring from a piece of 22-gauge rustless steel, bronze or hard brass wire, using a piece of 5/32-in. round rod, held in the three-jaw, as a mandrel. Bend one end of the wire at right-angles and poke it between the chuck-jaws, then pull the belt with your left hand whilst you guide the wire with your right. It will spring out, when released, to an easy fit on the rod. Touch both ends on your emery-wheel, or file them, so that they are



Section of regulator

squared off. The spring should be a good I in. long when uncompressed. See that both port-face and valve are absolutely clean, then put a spot of cylinder-oil between them when assembling ; put the spring on the regulator-rod, insert in barrel, put in the end plug, and secure it from coming out by a couple of 8-B.A. counter-sunk brass screws put through the barrel into the plug, as shown in the longitudinal section.

Connecting -tube and Gland Fitting

The regulator assembly is connected to the gland fitting on the backhead by a piece of 3/8in. copper or brass tube 6-13/16 in.overall length. Screw one end 3/8 in. by 40 for 1/4 in. length, and the other same pitch for 3/16 in. length ; then screw the longer end into the plug in the regulator body, the rod passing through it.

If a casting isn't available for the gland fitting, or stuffing-box, chuck a piece of 1-in. round brass rod *in* the three-jaw. Face the end, centre, drill about 3/4 in. depth with No. 21 drill, open out to 3/16in. depth with 11/32in. drill, and tap 3/8in. by 40. Turn down1/2 in. of the outside to 5/8 in. diameter, and part off at a full 11/16 in. from the end. Reverse in chuck, face the end, and cut back the flange to 1/8in. in thickness, leaving a slight projection in the centre, as shown in the longitudinal section, for sake of appearance. Open out the hole for 3/8 in. depth with letter T or 9/32in. drill, and tap” 5/16 in. by 32. Drill six holes in the flange with No. 40 drill, for fixing-screws, same as a cylinder cover. Make a gland from 7/16in. round rod, same as piston-glands, but drilled No. 21. Screw this completed gadget on to the end of the connecting-tube, so that the distance between it and the regulator-barrel is 6-3/8 in., as shown.

On the centre-line of the backhead, 5/8 in. from top of wrapper, drill a 5/8in. pilot hole, and open it out by stages to 5/8 in. diameter. If you try to drill it full size at one go, you’ll get a polysided hole ; I usually finish mine with a reamer. The plate around the hole must be perfectly flat and smooth ; judicious use of a file will do the needful. Cut a piece of 1/4in. copper tube, about 20-gauge, to 2-7/8 in. length, screw one end 1/4 in. by 40 for 3/8 in. length and the other end for 1/4 in. length. Screw the latter end into the regulator, with a smear of plumbers’ jointing on the threads. Poke the whole box of tricks through the hole in the backhead, and wangle the end of the 1/4in. pipe through the 3/8in. tapped hole in the smokebox tubeplate. Cut a piece of 1/4in. tube 1-1/4in. long, put a few threads, 1/4in. by 40, on the end, and screw it into the hole in the top of the regulator barrel. When this merchant stands vertically in the dome hole, the regulator is adjusted O.K. and you can go ahead and drill and tap the backhead for fixing-screws, making countersinks on the backhead with a No. 40 drill put through the holes in the flange. Follow with No. 48, and tap 3/32 in. or 7-B.A. Unscrew the vertical pipe, take the whole’ doings out, put a Hallite or similar jointing gasket. cut from 1/64-in. material, over the boss of the flange fitting, and replace. The flange is secured to the backhead by 3/32-in. or 7-B.A. brass round-head screws 3/8 in. long, the gasket preventing any leakage, and the vertical steam-pipe can then be replaced “ for keeps.” The dome can also be screwed down with a similar gasket between the contact faces. Pack the regulator gland with a few strands of graphited yarn, and fit a handle. This can be either as shown, or your own pet pattern.

To make the one illustrated, file it from a bit of 1/16in. by 3/8in. steel strip, to the same shape as the arms on the weighbar shaft. silver-soldering a boss on the larger end and in the same manner. which is first drilled and then filed square, to fit the square on the regulator-rod. Turn the grip from a bit of 1/8in. round steel held in three-jaw, and form a 3/32-in. pip on the end, which is driven through a 3/32-in. hole drilled in the narrow end of the handle. The whole issue is secured to the rod bv a nut as shown. Be careful to file the square hole in the boss, so that when the regulator is shut, the handle is in the position of the clock-hands at 2:10. Move anti-clockwise to open the regulator.

Steam Flange and Wet Header

Chuck a bit of g-in. round rod in the three-jaw ; face, centre, drill 5/8 in. depth with 7/32-in. drill and tap 1/4 in. by 40. Turn down 3/8 in. of the outside to 5/8 in. diameter ; further reduce 1/4 in. to 3/8 in. diameter, and screw 3/8 in. by 40. Part-off at a full 1/2 in. from the end ; reverse in chuck, and take a truing-up skim off the face. Put a smear of plumbers’ jointing on the threads, and screw the fitting on to the end of the steam-pipe sticking through the hole in smokebox tubeplate. The outer threads will engage with the tapped hole. and when right home, the whole lot will make) a perfectly solid and steam-tight joint. Hexagon rod mav be used if preferred, as it is easier-to screw home ; I use it if I have any the right size, otherwise I file a couple of spanner flats each side of the flange.

Chuck the rod again ; face, centre, and drill 7/32 in. for 5/16 in. depth. Part-off 3/8 in. from the end. Drill two 1/4in. holes in the edge, as indicated for the steam-pipes in the end view, and four No. 40 holes for the fixing-screws shown. It doesn’t matter if the bottom screw-hole pierces the pipe holes ; nothing will escape when the whole lot is assembled. For the water-tube boiler, drill only one hole in the edge.

Superheater

The elements are made from 1/4 in. by 20 gauge copper tube. Cut two pieces 7-1/2in. long, one 6-1/2 in. and one 8 in. The return bends are made from little blocks of copper 5/8 in. square and 3/8 in. thick. On one edge make two centre-pops 5/16in. apart. and drill in for 1/2in. depth with letter “D ” drill if you have one ; if not, use 1/4in. drill. The holes are drilled slightly on the slant, so that they break into each other just inside the block. Put a 7-1/2in. and 6-1/2in. tube in one, and a 7-1/2in. and 8-in. in the other, and braze them in, using either brass wire as a brazing material, or Sifbronze No. 1 ; don’t use silver-solder for this job, it is too near the fire. Soften the other ends of the tubes at the same heating ; after quenching in pickle, and washing off, bend the main part of the tubes parallel to each other, as shown in the illustration, and the ends of the 7-1/2in. tubes upwards. The 6-1/2in. one is left straight, and the 8-in. one bent horizontally, as shown in the plan-view. Round off the ends of the block bends as shown, which will prevent “ bird’s-nesting ” of cinders.

A tee-piece takes the place of a hot header, and this may be either a little casting or filed up from a bit of copper, like the return bends ; or a bit of brass bar would do. You needn’t be particular about the outside shape ; Inspector Meticulous never travels in the smokebox of a locomotive ! It is drilled either with letter “ D ” or 1/4in. drill, and the lower pipes fitted into it as shown in the plan-view ; the two upper pipes are fitted into the diagonal holes in the wet header. In the outer end of the tee, fit a piece of 1/4in. pipe about 2-1/2in. long, with a 3/8in. by 26 union-nut and cone on the other end. All the joints-wet header, tee, and union cone-can then be silver-soldered at one heat. Silver-solder is O.K. for the joints in the smokebox, as they are well away from the fire.

After pickling and washing off, the superheater can be fitted : nut the elements in the tubes. bending the diagonal tubes if necessary, so that the elements come nicely in the middle of the flues, and the wet header lines up with the flange on the smokebox tubeplate. Hold it temporarily in position ; poke the No. 40 drill through the screw-holes in the wet header, making countersinks on the flange, follow up with No. 48, and tap 3/32-in. or 7-B.A. Ordinary cheese-head steel screws are used for fixing, and a 1/64-in. Hallite or similar gasket is placed between 'the contact faces. The union extension-pipe beyond the tee may be bent roughly into a swan-neck, to keep it out of the way whilst the rest of the blobs and gadgets are being fitted to the boiler ; you cannot get it exactly to the right shape until the boiler is finally erected on the chassis. The superheater for the water-tube boiler is a plain loop of 1/4in. pipe running from the wet header, ***via*** the firebox casing, to the union fitting in the smokebox. It has no joints whatsoever.

Blower Pipe

This is not shown in the illustration. It is merely a 4-in. length of 1/8in. copper tube, one end of which is furnished with a 1/4in. by 40 union nut and cone, to screw on to the end of the thoroughfare nipple on the smokebox tubeplate. The other end carries a weeny edition of the blast-nozzle, made from 3/16in. hexagon brass rod and drilled No. 70. It may be screwed or silver-soldered to the blower-pipe, just as you fancy. The pipe is bent into an inverted swan-neck, and the tiny nozzle set alongside its more hefty relative-" mother and baby "-so that the steam from it blows up the chimney. " Ma" looks after the job of keeping the home fires burning whilst the engine is running, and " baby's " gentle breath keeps them from going out whilst the engine is standing. You hear a lot of tales about engines working without a blower. Beginners may be interested to know that on ***modern full-sized locomotives with short chimneys, there is no natural draught.*** Several enginemen have received fatal burns through not putting the blower on before shutting off steam. The late King Boris of Bulgaria once took a train to its destination after an accident of this kind. Many people reckon that if he had " turned in " the throne and stuck to the footplate, he would still be alive, happy and jolly. It's a funny world ! Mr. Chifley, the Australian Premier, was once an engine-driver, so Australian enginemen should have a good friend " upstairs " !

Safety-valve

The safety-valve is a plain ball non-pop of ample capacity to relieve the boiler. To make it, chuck a piece of 5/8in. hexagon rod-bronze if you can get it ; brass if not-face the end, and turn down 5/8in. length to 1/2 in. diameter. Centre, drill down 1-1/4in. depth with 13/64in. drill, open out with letter " R " or 11/32-in. drill to 5/8 in. depth, and bottom with a D-bit to 3/4 in. depth. Tap the upper part 3/8 in. by 32, and part-off at 1-1/8 in. from the end. Reverse in chuck, gripping by turned part :turn down 5/16 in. of the end to 3/8in. diameter,.and screw 3/8 in. by 26. Poke a 7/32-in. parallel reamer through the remains of the 13/64-in. hole

For the nipple, chuck a piece of j-in. round rod in three-jaw ; face, centre, and drill No. 30 for about 1/4 in. depth. Screw the outside 3/8 in. by 12 and part-off a 3/16in. slice. File or mill two nicks in the edge, as shown in the plan-sketch. For the cup and spindle, chuck a piece of 1/4in. rod in three-jaw ; turn down 11/16 in. length to 1/8 in. diameter, an easy sliding fit for the hole in the nipple. Part-off at 1/8 in. from the shoulder ; reverse-in chuck, make a shallow centre, and open it to a full countersink with a 1/4in. drill, as shown in the section.

Seat a 1/4in. rustless-steel ball on the hole by the usual hammer-and-brass-rod wheeze, and wind up a spring from 22-gauge tinned steel wire. as described for the regulator, squaring off the ends in the same manner. Assemble as shown : the spring should just start to compress when the nipple has entered about one thread. The valve is adjusted, on the boiler, to blow off at 80-lb. gauge pressure. Next job, backhead fittings.

For the Bookshelf

Petrol-engined Model Aircraft, by Lieut.-Cal. C. E. Bowden, A.1.Mech.E. (London : Percival Marshall & Co.Ltd.). Price 7s.6d.net.

Written by an inveterate enthusiast, an indefatigable experimenter, and one who has amassed a wealth of practical knowledge of the design, building and-flying of petrol-engined model aircraft, this book is at once authoritative and instructive. Progress in the design and construction of miniature petrol engines has been so rapid in recent times, that the problem of equipping a model aeroplane with an efficient and reliable engine has now largely disappeared. Today, the question resolves itself more into discovering the best combination of engine and plane which will give the desired results ; and this book is full of information and suggestions born of actual experience. Mr. C. R. Jeffries has contributed an interesting and useful chapter on Radio Control. with excellent advice based on his own experiences during war-time experiments. The control of various kinds of moving models by radio is a fascinating field to explore, and much has already been done ; but it is subject to difficulties arising from regulations governing the selection and use of short wave-lengths. Colonel Bowden's book, however, should find a ready sale among all aeromodellers who would wish to apply the latest developments in petrol-driven models.

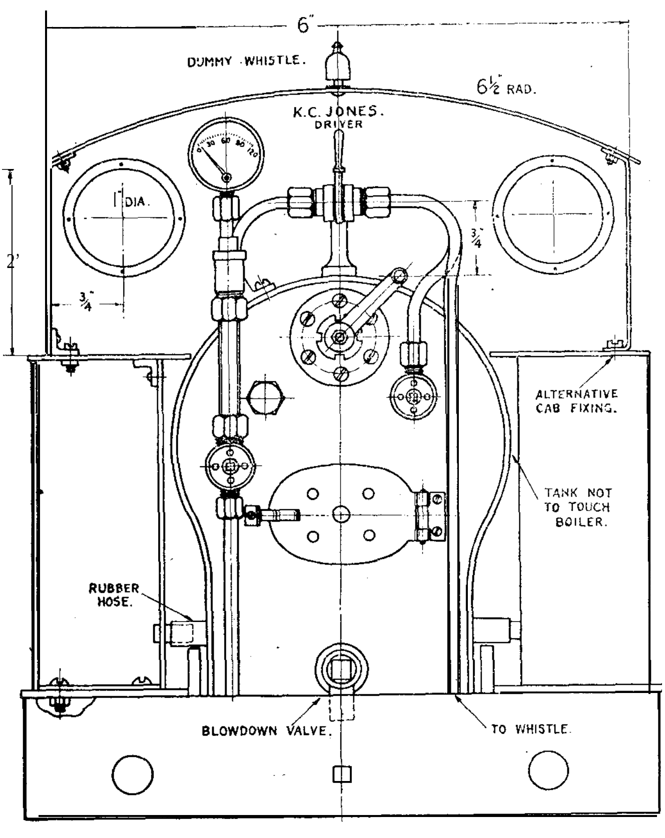
" 00" Gauge Layout and Design, by Ernest F. Carter (London : Percival Marshall & Co. Ltd.). Price 3s. 6d.

For those whose interest lies in planning layouts for miniature electrically-operated railways, here is a handbook of upwards of 100 pages containing practical guidance on how to approach the matter from first principles. The author's chief concern is to impress upon his readers the importance of following prototype practice implicitly and to adopt it according to the limitations of the space available for the miniature layout. Such other matters as station layouts, junctions, sidings of all kinds, locomotive depots, bridges, tunnels and so on. are dealt with concisely and lucidly. The book is illustrated by numerous typical diagrams as well as several photographs of prototype features relevant to the subject.

" L.B.S.C."

"JULIET'S" BOILER FITTINGS

WHEN describing how to make the footplate fittings for " Hielan' Lassie," I warned all " Juliet " builders to take particular note of same, as the fittings for " Juliet's" boiler would be similar, and a lot of needless repetition would be saved. If they didn't " heed the gipsy's warning" in a manner of speaking, well, it's just too bad ; because in dealing with " Juliet's " adornments I only propose to note where they differ in actual construction, from those on the " Lassie " Delinquents will have to rake out their back number for April **17th** last, and put in a spot of overtime !



" *Juliet's cab and fittings*

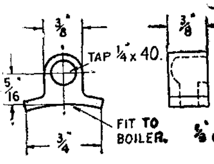
Starting from the top of the backhead, as per usual,, the working parts of the combined turret and whistle valve are made in exactly the same way, and are the same size, as those on the " Lassie's " gadget, the difference in personal appearance being what is sometimes called " of a threefold nature." First, the stem which screws into the top of the wrapper is a little more giraffe-necked, to enable the centre-line of the valve to stand 3/4in. above the top of the wrapper. Secondly, the union screw for the pipe leading to the whistle, is on the opposite side of the turret (right-hand side, from footplate view) as the pipe goes down on the opposite side to the gauge-glass blowdown pipe. Thirdly, the handle, instead of being horizontal, points to the stars. Any beginner can make those small alterations without having to be told how to do the whole lot over again ; he wouldn't follow these notes

There. are two slight differences in the water gauge. The union screw for the blowdown pipe, instead of being on the skew-whiff to miss the firehole door, is diametrically opposite to the bottom gland, so that the pipe connected to it drops straight down through the footplate. The upper fitting, instead of screwing direct into the backhead, fits into a socket which is attached to the edge of the firebox wrapper. This is shown separately in the little detail sketch, and may either be a casting, or sawn and filed down from a bit of 3/8in by 3/4in. brass bar, to the dimensions given. The bottom should be radiused to fit snugly on the wrapper. Drill the 7/32 in. hole in the upper part, either on a drilling machine, or in the lathe, with the drill in the three-jaw and the socket held against a drilling pad on the tailstock barrel, so as to be quite certain the top gauge fitting lines up with the bottom one. A 5/32-in. hole is drilled up the centre, as shown by dotted lines, and a No. 40. hole in each projecting lug.

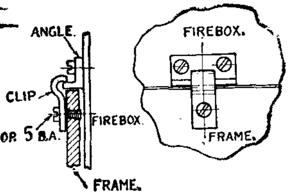
Next, at I in. from the centre-line of the top of the boiler, and 3/16 in. from the edge, drill another 5/32-in. hole, and put the fitting directly over it, securing it by two 3/32 in. or 7 B.A. brass screws, roundhead for preference. When fitting, screw a short bit of 1/4in. rod in the hole, and mount the socket so that this stands at right-angles *to* backhead, and parallel to the centre-line of the boiler. When set O.K., tighten the screws, and solder all around it ; if you hold a hot soldering bit against it, with a small blob of solder and a brushful of liquid flux, and then play a small blowlamp or blowpipe flame on the joint at the same time, the solder will flash clean through, leaving a neat and sound joint. Be sure to wash off any flux. The water gauge is then erected, and the glass put in, just as I detailed for the " Lassie "

The regulator and blower valve you already know about. The latter is connected to the right-hand union on the turret, by a piece of &-in. copper tube with a union nut and cone on each end, as shown. Don't fit the whistle pipe until the noise-producer is ready for erection ; you can make it when you like, same as described for " Lassie " last week, and fit it later, when side tanks are on, the clips being attached by the same nuts holding down the tanks. A *3/4in.* steam gauge reading to 120 or 150 lb. is the next requirement, and is the only component I ever advise anybody to buy ready-made. Although I have given full instructions for making steam gauges, it is a very fiddling job at the best of times and apart from the delicate work involved, you have to get a big gauge in order to calibrate the small one, so might as well save time and trouble by buying a small gauge right away, and have done with it. It is attached to the left-hand union on the turret, by an inverted swan neck of 1/8in. tube, with appropriate union nuts and cones. The big engines' gauges are usually attached to the cab front by screws through the flanges; but apart from the fact that small gauges are usually flangeless, it would be out of sight to a driver on a flat car behind the engine, so set it far enough back, to be easily seen.

The blowdown valve is the same as " Lassie's " and is situated in the centre of the backhead, just above the foundation ring. If the boiler is blown down now and then, with about 20 lb. pressure on the gauge-make sure the fire is out !-is should need very little washing out ; but if a lot of " fur " accumulates, as it may do in districts where the water is chalky, the boiler can be cleaned by taking the blowdown valve right out, and removing the. dome. A small bent nozzle down the dome hole, coupled to the domestic water tap by a suitable bit of rubber hose, will soon shift all the dirt and scale.



Socket for top of water gauge

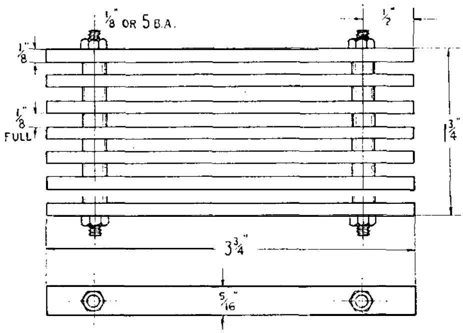


Boiler clip

On a simple job like " Juliet " there *is* no need to bother about riveting separate hinges on to the firehole door. If a casting isn't available (it should be) cut out the door from 18-gauge sheet steel, and leave two 1/8in. tags on one end, and one ditto on the other. Bend the former into loops for the hinge pin, and the latter into a handle. The door is kept closed when needed, by a spring catch same as " Lassie," but you'll probably have to open it a bit when running, to save a lot of blowing-off. My old " Ayesha," now in her twenty-sixth year, is still a dabster at blowing-off ; and the only time the firehole door is shut, is after firing up, and the injector is working. Well, that settles the fittings ; now all we need before erecting the boiler, will be the grate and ashpan.

Grate

Up to time of writing, the cast grates haven't materialised ; advertisers tell me that it is the very dickens of a job even to get foundries to cast small wheels, let alone grates. *Cela nefaire rien*-we'll have to make one. Seven pieces of black strip steel, each 3-3/4in. long, 5/16in. wide, and 1/8in. thick, will be needed. Drill a No. 30 hole 1/2 in. from each end of one, and use as a jig to drill the rest. A dozen spacers are made by chucking a piece of 1/4in. round steel, centring, drilling No. *30* for about an inch depth at a time, and parting off slices to a thickness of 1/8 in. full. The bearers are two 2-1/4in. lengths of 1/8in. rustless steel ; the rough-drawn stuff will do fine. If not available, use mild steel ; but the rustless is best, as there is always condensation in the firebox when the engine is cold, same as in full size, and the moisture gets down to the bearers and rusts them away. I have had one or two grates collapse, owing to this, so now use rustless steel for all engines, and have had no further trouble. Put a few threads on each end of each bearer, either 1/8 in. or 5 B.A. ; assemble as shown, using ordinary commercial steel nuts, and have the same amount of bearer projecting beyond the nuts at each side of the grate. The projections locate the grate in the firebox, fitting into niches filed in the lower edges of the firebox side sheets. Don't forget that the spacers must be a weeny shade over 1/8in. wide, so that the grate measures 1-3/4 in. over the outside firebars, when the nuts are tightened up.



Details of grate

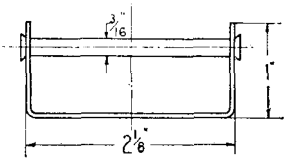
Ashpan

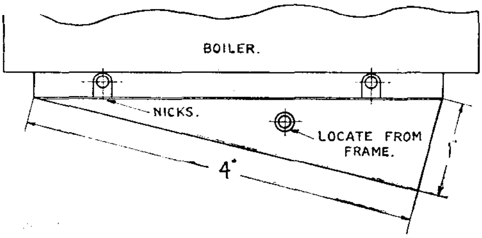
The ashpan certainly is about " the simplest ever."It is made from a piece of 18- or 20-gauge sheet steel, *4* in. by 4-1/8 in., marked out and cut to the shape shown *in* the illustrations, and bent *on* the dotted lines. Tip to beginners : when bending up a job to conform to a fixed overall dimension, don't forget to allow for the thickness of the metal, when setting the job in the bench vice ready for bending. In the present instance, catch the piece of sheet metal in the vice with the triangular part upwards ; but the dotted line must not be exactly level with the top of the vice jaws. Set it *above the* vice jaw, a distance equal to the thickness of the metal ; then hammer it over. Reverse the metal and repeat process ; if a piece of iron bar I-in. wide, or a little over, is placed in the bend already made, there will be no trouble in holding the work for the second bend. I keep a box handy to the bench vice, with a number of pieces of steel bar of different sections, to " pack out " on bending operations, and find them jolly useful time-savers. The tube for the retaining pin cannot be put in until the boiler is erected on frames, so this will be the next job.

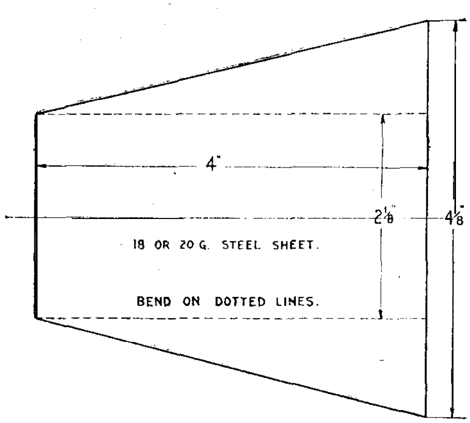
How to Erect Boiler

If you haven't already done so, connect up the wet header of the superheater to the steampipe flange, and put the smokebox on the end of the boiler barrel, with a smear of plumbers' jointing to ensure it being airtight. If any air leaks into the smokebox, the partial vacuum induced by blast or blower is destroyed, and the boiler won't steam, the fire either burning very dull or going out altogether, for lack of oxygen being drawn through it. The boiler should enter the smokebox about 3/16 in., and if a good fit, won't need any further fixing ; but if at all doubtful, drill three or four No. 48 holes, clean through smokebox and end of barrel at the overlap, countersink them, tap 3/32 in. or 7 B.A., and put in brass countersunk-head screws. Warning to beginners : see that the chimney is up straight and lining up with dome and safety valve ; otherwise the-boiler when erected, will look as though it had had " one over the eight," not to mention the party who did the job !

Set the smokebox and boiler on the frames, the bottom of the smokebox (or saddle, if you have used the separate saddle) going down between the frames above the cylinders, for about 1/4 in. The longtitudinal position of boiler will be-settled by the holes for the blastpipe and steam pipes in the bottom of the smokebox. The bottom of the boiler should be approximately 3/8 in. above the frames; so if you lay a couple of bits of 3/8 in. rod or bar across the frames at each end of the barrel, and push down the boiler to rest on them, you won't be far out. Drill three No. 44 holes through frame and bottom of smokebox or saddle at each side ; then lift the boiler off, open out the holes in frame with No. 34 drill, tap those in the smokebox bottom or saddle 6 B.A., replace boiler, and secure with hexagon-head screws. I specify this size because the heads are fairly small and look neat, also there seems to be plenty about, as they were much used during the war ; but you can use 5 B.A. or any other size that might be handy, if 6 B.A. are not available.







Details of ashpan and how to erect it

The firebox end is carried by two expansion brackets. These are 3/4 in. *lengths* of 1/16 in. by 3/8 in. brass angle with one side filed away to a full 3/16 in. ; but you can bend up a bit of 16-gauge sheet copper or brass, to form the requisite angle if desired. Drill two No. 34 holes in the wider side, place at side of firebox with narrower side resting on frame-exact position immaterial-and run the 34 drill through the holes, making countersinks on wrapper sheet. Follow with No. *44,* tap 6-B.A. and ‘secure with brass screws. Finally sweat over the complete bracket and screwheads, as described for the water gauge socket. The clips to prevent the boiler lifting, are shown in the detail sketch which is self-explanatory ; they are made from scraps of 16-gauge sheet brass, copper, or steel, and attached to the frames by means of a solitary 1/8in. or 5-B.A. screw, running through a No. 30 hole in bracket, into a tapped hole in frame.

Now connect up in smokebox, putting the nozzle on the blastpipe, and screwing the superheater union to the steampipe. The blast nozzle can be lined up with the chimney by poking a length of silver-steel down it (5/32 in. should fit exactly) and bending the blastpipe, if necessary, until the rod stands straight up in the middle of the chimney. The blower pipe you already know about, as it was described in the previous " Juliet " instalment ; but if anybody would care to make an extra posh job of the blower, they can fit a ring instead of a single jet, by following the instructions given for " Lassie's " blower, but using one ring only instead of the twin arrangement. Make sure the jets of steam blow towards the centre of the liner, and not outwards. All interstices where the pipes pass through the bottom of the smokebox should be sealed, either with asbestos " putty " made by wetting a few scraps of asbestos millboard and kneading them up to the consistency of putty, or else smearing some plumbers' jointing on a few strands of asbestos string and winding them around the pipes close to the bottom of the smokebox. finally pressing down to form a grummet. See that the smokebox door closes airtight, and that's that !

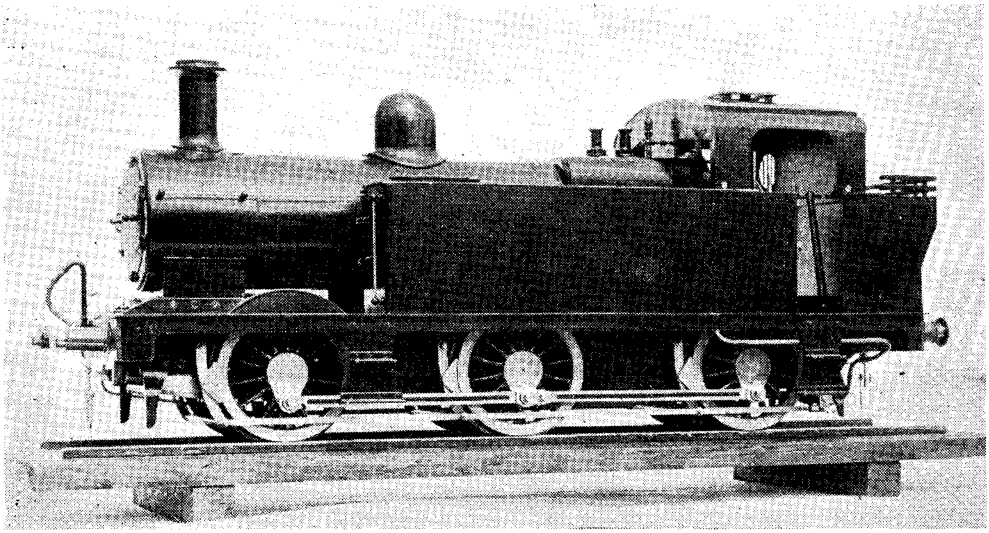


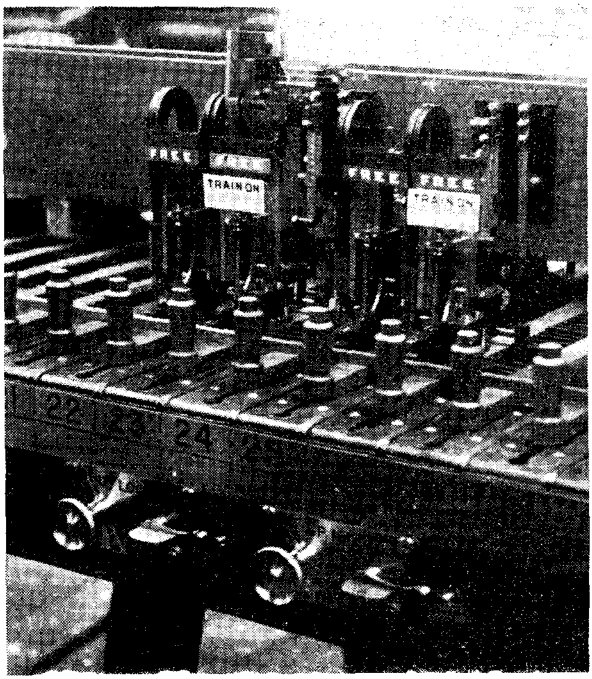
Photo by] *[C. J. Grose*

A fine "Molly" built by Mr. Evans of the Sutton M.E.C.

Now turn the engine upside down on the bench : I use a couple of felt-lined wooden chocks to support the barrel, without damage to the mountings. At 4) in. from back of frame (measure from inside of buffer beam) and 1-3/4 in. from bottom, drill a No. 30 hole through both sides of frame. Drop the grate into the nicks at bottom of firebox ; incidentally the easiest way of forming the nicks, is to drill a 9/64-in. hole at 5/32 in. above bottom of firebox, and 23/32 in. from each end, then file down to them with a thin flat file, to shape shown in illustration. This is, of course, done before erecting boiler. Put the ashpan in place, so that it rests on the bottom edges of the firebox. Run the 30 drill through holes in frame, and make countersink on the sides of ashpan. Remove same, drill out the countersinks with 3/16in. drill, then put a piece of 3/16in. copper tube 2-1/4in. long, through both sides of the ashpan, slightly belling the ends with a centre punch to prevent the tube falling out. The hole through the tube must be large enough to take a 1/8in. pin, which is made from a piece of 1/8in. silver or mild steel, about 3-1/2in. long. File one end to a rounded point, make a knob from brass or steel rod, and screw it on to the other end, and poke it clean through the frames and ashpan tube. It holds up the ashpan to the firebox, and the ashpan in turn keeps the grate in position. If the pin is pulled out at the end of the run, the whole issue falls clear of the engine ; but mind that you clean the eccentric straps afterwards, so that no grit gets in and grinds them away. Apart from arranging the ashpan on the slant, to clear the straps, the sloping bottom allows anything falling through the bars, to roll down on to the permanent way ; and the ashpan, though necessarily shallow because of the "works " underneath, can never become choked up, and put the fire out.

Make up two clack boxes, as described for the "Lassie," in the issue previously mentioned. Drill two 1/8in. holes on the centre line of " Juliet's "boiler, 1-1/2 in. from the smokebox ; check the exact height each side with your scribing block, or if you haven't one, use *a* rule, with one end resting on the bench. Open the holes to 7/32 in. tap 1/4in. by 40, and screw in the clack box stems, so that the bodies stand vertical ; then sweat them in, as described for the water gauge socket. Remove the balls whilst doing this, because some kinds of rustless balls aren't rustless any more if they are heated above a certain temperature. If you like, 1/4in. by 40 bushes could be silversoldered into the boiler, when doing the dome and safety-valve bushes, and the clacks screwed into the bushes, instead of being screwed direct into the boiler shell and sweated over. The only thing is, if you adopt that method, don't make big unsightly bushes, so that the clacks stick out like a goblin's ears ; on a big engine, they are fitted close to the boiler, and usually are small and neat. Well, all we need now to complete, are the side tanks, cab, a few bits of pipe, and trimmings, which I will deal with, all being well, in the next " Juliet " instalment. Water-tube boiler devotees please note,

(Continued on page 163)



Miniature slides on Sykes electro-mechanical frames

between those connected to the point levers, so that, whereas the point levers are pitched 5-1/4 in. apart, the tappets in the locking troughs are 2-5/8 in. apart.

The solenoid for the electric locking, as illustrated in Fig. 2 is of conventional design. A brass pedestal casting spans the slide itself, and the cross ribs of this casting also provide guides for the plunger and the lock. The iron shell has an outside diameter of 1-7/8 in. and is 1/8 in. thick ; into this the iron bottom plate *-in. thick is screwed, and the shell itself is screwed into the pedestal casting. The stroke of the plunger is 1/4 in.

The operating contacts are illustrated in Fig. 4. They are carried on a wooden board, 6-1/2in. high by 3/4in. thick which extends the full length of the frame. On this board is mounted a piece of ebonite, or other suitable insulating material, and to this the cast brass pedestals carrying the contact fingers are screwed. These pedestals, it will be noted are in pairs, one left-hand and one right-hand. The contact fingers are set with a bias towards one another at their outer ends, and are spaced apart by the ebonite roller 3/4in. diameter. The bridging-piece is mounted upon an insulating block carried on the slide, and it will be seen that the end first engaging with the fingers is flared to give a smooth entry.

In concluding these notes on the Sykes electro-mechanical frame I would once again express my gratitude to Mr. T. S. Lascelles, Managing Director of the W. R. Sykes Interlocking Signal Co., for his very kind assistance.

(To be continued)

" L.B.S.C."

(Continued from page 160)

fit your clacks on the backhead ; either at the sides, on the centre line, or if you like, in place of the two outer water-tube cleaning plugs. In the latter case, the incoming water will shoot straight up the tubes and help to keep them clean.

A **Sad Catastrophe** !

The other week a correspondent facetiously asked why it was that, as the Polar Route tried to follow big practice in every way, we didn't manage to have a bit of a wreck, or even a derailment, seeing that the big railways had been busy of late in that respect. Well, he just spoke out of his turn ! On the evening of June 26th last, as the 9.5 p.m. down passenger train, engine 6003 G.W.R. four-cylinder 4-6-0 " King George IV," driver T. H. Glazebrook of Thornton Heath shed, was entering Purley Oaks south curve, the last coach jumped the road, tore up several sleepers and a number of rail fastenings, tumbled off the trestle and decanted the passengers in the ditch. The driver was unaware of anything happening until an emergency brake application pulled him up dead. Fortunately the accident happened right opposite the permanent-way store ; and in a few seconds the gang were on the job with new sleepers and rail fastenings. There was no damage to rolling stock, nor injury to passengers ; and in less than 15 minutes, normal service was resumed.

At the official inquiry into the cause of the accident, the permanent-way inspector said he had been over the line during the afternoon and found that it was all in order, the only defects being lack of replacements due to the usual shortage of materials and labour ; but the alignment was quite suitable for normal traffic. Driver S. F. Sibley, also of Thornton Heath shed, corroborated this, and stated that his engine " Springfield Grange " had taken the curve well over the recognised speed limit, a little while previous to the accident, and there had been no sign of anything the matter with the road. Supt. Curly gave evidence that he had also been over the road with a heavy goods engine, which would have certainly given any warning if the road had been defective. The final verdict was, that the passengers must have been so interested in a passing Milly Amp, that the train arrived at the curve before they were aware of it, and the sudden swerve caught them off their guard and upset the whole box of tricks !